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DECEMBER, 1923

THE DUCHESS CATTLE
SEWALL WRIGHT

CAUSES OF DEFECTIVE CHILDREN
M. G. SCHLAPP

ASIATIC BREEDS OF SHEEP
C. C. YOUNG

A NEW METHOD OF GRAFTING
T. RALPH ROBINSON

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CONTENTS

CAUSES OF DEFECTIVE CHILDREN....M. G. SCHLAPP 387

A NEW METHOD OF GRAFTING...T. RALPH ROBINSON 399

MENDELIAN ANALYSIS OF THE PURE BREEDS OF LIVESTOCK, II. The Duchess Shorthorns. SEWELL WRIGHT 405

CORN AND CORN GROWING (A REVIEW)..... 422

THE ASIATIC BREEDS OF SHEEP, Considered from the Standpoint of Tail Formation.....C. C. YOUNG 423

ERRATA 432

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Date of Issue of this Number, January 31, 1924

DEFECTIVE CHILDREN ASCRIBED TO BAD ENVIRONMENT

The girl at the left was born before her parents left their home in Italy, and is a happy and normal child. The two microcephalic boys were born after the family had lived in New York. Dr. Schlapp has observed hundreds of such families, that have come to America with one or more normal children, but whose first children born in this country, where their parents were living under congested city conditions in New York, were defective. Later children of the same families are likely to be normal. Dr. Schlapp maintains that the defectives are the result of an alien and unnatural environment that disturbs the balance of the endocrine secretions of the mother. If the modern industrial city is an environment so ill suited to the people living in it that such effects can be induced, the facts need to be known. The mothers of the definitely defective children usually suffer severely from home-sickness or other emotional disturbances, but it is believed that children who are not reckoned as defectives may fall below normal heredity as a result of the adverse conditions of urban existence. Support and care of defectives and deficients is becoming one of the great burdens of civilization, and is rapidly growing heavier. If these unfortunates represent only the extremes of a general deterioration that is going on, the outlook for progress under urban conditions is indeed somber.—*Editor.* (Frontispiece.)

CAUSES OF DEFECTIVE CHILDREN

Prenatal Development Affected by Glandular Disturbances in the Mother—Induced by Unfavorable Environment

MAX G. SCHLAPP

Professor of Neuropathology in Post-Graduate Medical School and Hospital. Director of Children's Court Clinic, New York City.

(Photographs copyrighted by the Author.)

RECENT studies of mentally defective children and their mothers have served to emphasize the fact that prenatal pathological conditions in the female parent are responsible for certain definite malformations in the child. These investigations have thrown light upon the causation of many obscure defects and deformities. More specifically, they have proved, for the first time, that to certain chemical imbalance in the blood of the mother can be traced the cause of many of the strange, monstrous unfortunates who have been born into the world and of whose peculiarities history has defied any explanation outside the realm of superstition.

For some years we have understood, from laboratory experiments on lower animals, that the introduction of extrinsic poisons into the female parent will bring about weaknesses, abnormalities and monstrosities in the offspring. Notably is this the case where the parent has been subjected to the toxic effects of morphine, alcohol or the like. But it is only now that we are beginning to realize that internal factors having to do with disturbances of the ductless glands are the chief causes of these mysterious malformations in children. Indeed, such malformations have heretofore been particularly baffling in view of the fact that the parents were, in many cases, apparently healthy individuals who revealed none of the stigmata so badly evident in the progeny.

At this point the reservation must be noted that intrinsic toxins, such as result from focal infections and infectious diseases, play a subordinate part in the prenatal history of the misbegotten. This part is, however, secondary as well as subordinate, the toxin most likely acting primarily upon the endocrine organs of the mother, which in the resulting pathological condition, fail to do their part in the development of the child.

With the number of mental defectives and deficients steadily mounting, the economic situation ever becoming more inimical to all weaker individuals, and the burden of public charity straining the state purse, locating the source of supply of the mentally handicapped becomes of vital importance, not only medically, but socially. An understanding of the profound causes of these conditions alone holds out the promise of their treatment and correction; namely, decreasing the begetting of these individuals and the certainty that many of them, notably the cretins, can be normalized after birth must be welcomed as an addition of the first rank to the sum of our medical and social progress.

The Causes of Abnormal Development

To understand the etiology, or the general and specific causes of such disturbances as are responsible for the birth of mental defectives, we must go back to the life processes of those fundamental organisms, the living cells. Of these processes there are only three: the nutritive, the formative and the functional. The nutritive process

is that activity by which the cell takes into itself nutriment from the surrounding medium (as in the case of the amoeba living in the sea water), and stores this food as potential energy. The formative process is commonly called cell division. It is the process by which organisms grow, and it is with this matter of growth that we shall have most to deal in this connection. The functional process—which does not especially concern us now—is the part of all life that is devoted to some specific activity, such as the contraction of a muscle cell, the secretion of a gland cell, the impulse transmission by a nerve cell or the simple locomotive movements of an amoeba.

Thus, like all living creatures, the cells which make up the body engage in three principal activities: feeding or absorbing energy, growing or reproducing, and functioning or performing some special act or labor in which the stored energies are consumed. It would seem a platitude to say that if a human being is fed on bad food he will sicken and will be able neither to grow nor to work, but it is stating a fact as yet not generally recognized to apply this bit of common sense to the cells of which that human being is made. Particularly does it seem almost startling to apply it to the cells of the unborn child.

Just here lies the core of our problem. The formative process of the cells in the human embryo is dependent upon a chemically normal medium—a healthy blood condition in the mother. Expressed in the simplest terms, this process must have a well balanced ration of food peculiar to it. If this condition prevails, and there has been no serious involvement of the germ plasm, the various groups of cells in the foetus will develop normally and we shall have—other troubles not intervening—a healthy child. We know, however, that toxins of all sorts act selectively on special cell groups, inhibiting or exaggerating their growth. Thus the presence in the mother of any kind of extrinsic or intrinsic poisons may cause the development of monsters. The same rule is now known to apply in any case where the chemical medium on which the growing cell feeds is seriously disturbed by abnormal functioning of the internal secretory glands.

A parallel is to be found in primitive marine life. Not only are the simple organisms that float in the littoral waters of the sea killed or injured by the presence of hostile chemicals, but also by variations in the salt content or the temperature of the brine. The medium upon which the human embryonic cell feeds and in which it lives is precisely comparable to the amoeba's sea water. If the endocrine balance of the mother becomes disturbed from any cause, such as worry, strain, emotional shocks, grief, fright, constant excitement and the like, during the course of the gestation period, there is the gravest likelihood that the chemical balance of her blood will be deranged, that certain cells which live in it and feed on it will grow abnormally or refuse to grow at all, and that another defective will be born.

Typical Cases

Case 1. A family of Italian peasants was attracted to America because one of the neighbors had returned to the home village in what seemed a golden prosperity. This man had gone to America ten years before and, after the usual struggles and defeats, had prospered in a small way. In his new felicity he forgot his early trials and told only of triumphs. The peasant family sold what it owned, hopefully packed a few belongings and set out from that peaceful, normal environment in which the stock had grown from the time of the Caesars, to stake its small strength against the industrial giant, yawning across the sea. Of these wayfarers there were only three, the parents and one daughter, a happy and normal child. (See Frontispiece.)

These strangers settled in New York. Their poverty was pitiful; their

struggle to adjust to a totally alien environment worse than brutal. The mother was forced out into the economic fight. At about the same time she became pregnant with the second child. That rest, that repose which all women need for the labors of child creation, was denied her. Instead of the cool mornings, the hot days and the long purple evenings of her Ligurian hills, she had the drudgery of a mill for her ease. Naturally, she was seized with a powerful nostalgia. Her home and her past beckoned her out of the inferno into which she had wandered. Outwardly, the miserable woman's emotions cooked over into constant tears. Inwardly, they seethed up into a very grave disturbance of the endocrines. In this condition she struggled through the forming and bearing of the second child, and then of the third. At length, something of the measureless tragedy of her situation weighed upon her, and she came to the clinic with her microcephalic children—idiots. (Again see Frontispiece.)

It was impossible to induce this mother to submit herself to the various metabolism tests, but even outwardly she gave unmistakable evidences of a disturbed metabolism due to chemical imbalance. She was not, however, in the least microcephalic. And it will be well, at this point, to accentuate the fact that mothers of microcephalic children rarely, if ever, show any of the faults of their unhappy progeny. Our problem, in these cases, is apparently one of prenatal chemistry, not of heredity. If these pathological types were to breed, no doubt many of the cases would reproduce a similar defect. In other words, we have here possibly a mutation. These cases, however, being so defeective, there is no possibility of their breeding. How many such defects may be continued by heredity after once having been established by serious environmental changes is not known, although Stockard, of Cornell, has shown that malformation produced in the offspring by extrinsic toxins being introduced into the parent can be lost in three or four generations and the animal returned to the normal condition. If the pathological change in the offspring of a disturbed mother is slight enough not to inhibit reproduction, it may very readily be continued for a number of generations. This mother showed symptoms indicative of constitutional imbalance caused by endocrine disorder, such as depression, intense restlessness, insomnia, loss of appetite and of weight, tremors, profuse perspiration, palpitation of the heart, and so forth.

Case 2. We have here an American-born mother of four children, all of them born within five years. (See Figure 1.) It will be seen that the first and the second children are perfectly normal. The third child followed fast upon the two earlier ones, and, to make matters worse, the mother, in the first month of pregnancy with this child, contracted influenza and was in bed for three or four weeks. After the illness she was unable to recover her strength, and in this depleted state of her forces she passed through the remainder of the child-bearing period. The fruit of this set of circumstances is, as may be seen, a typical Mongolian idiot.

The mother could not nurse the child, but after some months she recovered strength rapidly, and within fifteen months after the birth of the third child she brought the fourth child into the world. This infant gave all the normal responses and is apparently healthy.

Mongolian Idiocy Due to Endocrine Disturbance

It is, of course, well known that the Mongolian type of idiot is commonly the child of a mother who is nearing the menopause. At this period of a woman's life the hormone balance is seriously disturbed. From my own observations and those of many others, it is now safe to conclude that Mongolian idiots are also frequently born of younger women whose endocrines have been disturbed by the drain of in-

MONGOLIAN IDIOCY DUE TO UNBALANCED HORMONES

FIGURE 1. It has long been a matter of observation, recently confirmed by statistical studies, that Mongolian idiots are in the great majority of cases the children of women nearing the menopause, a period when the harmone balance is known to be disturbed. This type of defective children is also born of mothers who have had the normal secretion of their ductless glands upset by the drain of infectious diseases, or from other causes. In this case the mother contracted influenza about eight months before the birth of the third child who is a Mongolian idiot. The three other children are apparently normal, their startled appearance is due to being photographed by flashlight.

fectious diseases or other causes, such as emotional strain, exposure to industrialism, and so forth.

Since Mongolian idiots are invariably alike, it is to be deduced that a uniform type of disturbance is responsible for them. And, since we know that such an offspring is borne most frequently by women suffering from endocrine disturbance common to the pre-menopause state, we may safely conclude that the misbirth in this case (Figure 1), was not directly due to any of the intrinsic toxins of the influenza from which the mother had suffered, but that its causation was of secondary nature. That is to say, that the peculiar type of abnormality of the child may be accepted as convincing evidence of a condition in the mother analogous to the endocrine disturbance in the women who are most frequently the mothers of this type of child.

Effect of Environment on Type of Children

Going back to Case No. 1, it is important to note that, in my own clinic

at the Post-Graduate Medical School and Hospital, *we have recorded hundreds of cases* in which immigrant couples who had produced normal children in Europe, under familiar environment, have, after their arrival in this country and their projection into the unfamiliar and enervating social and economic situation, brought forth one, two and in rare instances more defectives.

It seems to me that there can be no question that the emotional nature of man, and particularly of woman, plays an important part in bringing about the chemical disturbance which is responsible for such abnormalities. The homesickness of these mothers is always marked, and this is the beginning of a general emotional involvement. Strangely, and yet naturally enough, after four or five years, when the immigrants have become adjusted to their new environment, they bring forth healthy children again.

In the case of Mongolians and microcephals, the endocrine disturbance in the mother has evidently been grave, resulting in a serious derangement of the formative process of the cells in the child. Unhappily, in the present state of our knowledge we are unable to treat such children successfully. But in all probability we could prevent the occurrence of these abnormalities in children of previously healthy young mothers, if the normal chemical balance of the mother could be restored by treatment before the conception of the children. Not only are we unable to help such children materially, but we do not know precisely what glands of the mother or of the child are involved. We have the suspicion of a pluriglandular involvement, and this notion is sustained to some extent by the fact that such cases have been kept under pluri-glandular treatment for periods of from eight to ten years and good results have been secured, without, however, having been able to achieve normality. The well-known short-livedness of such seriously defective individuals and their great susceptibility to infectious diseases would also seem to support this idea.

It will be seen from both the above cases that strains and drains on women are and must be responsible for the birth of many inferior children. How slight or how grave the inferiority may be will depend, of course, upon the degree to which the mother has been impoverished or harmed.

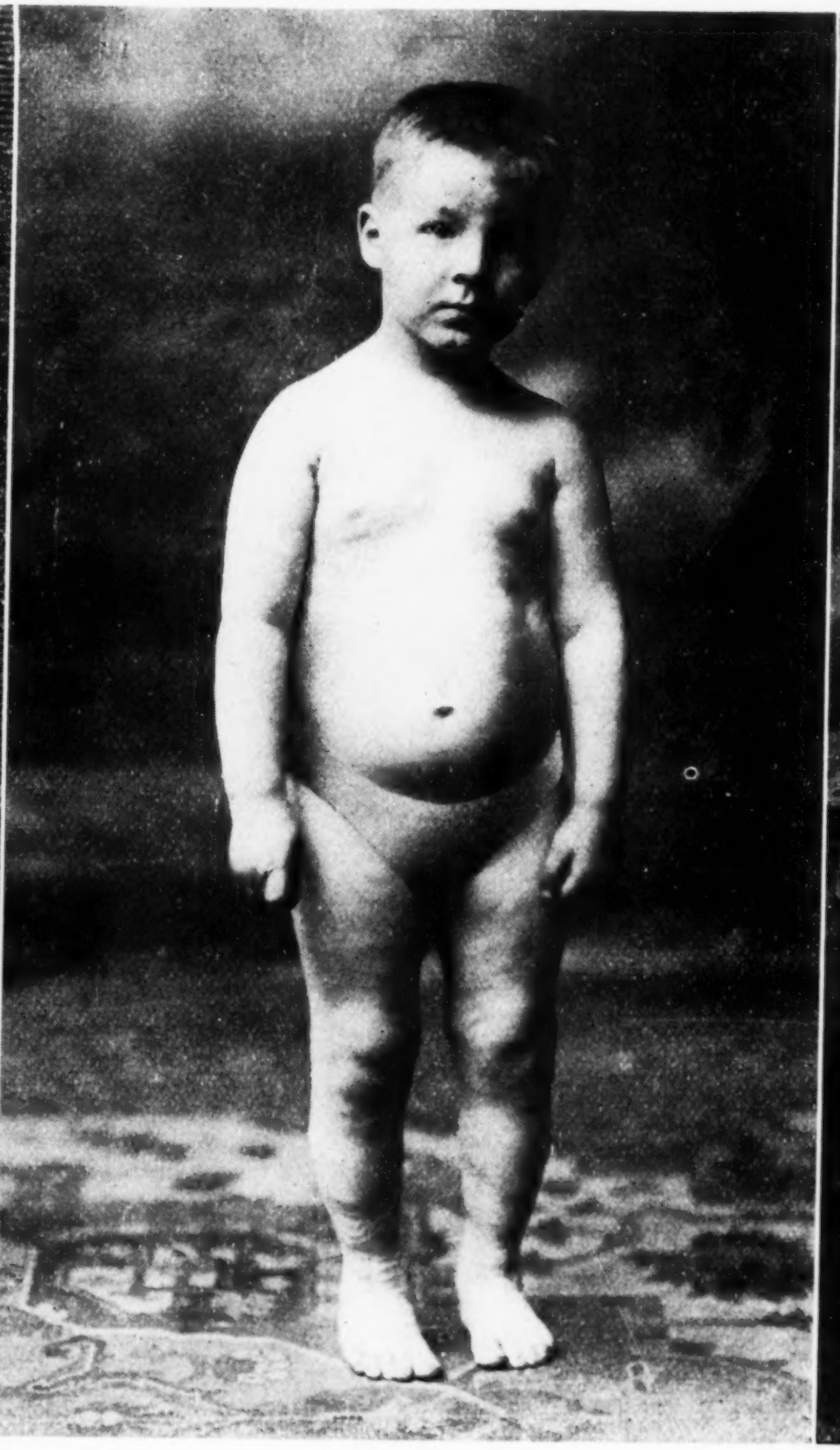
Women in Industry and Business

Nothing is more certain than that woman is especially adapted by nature to the anabolic process of storing up energy to be used in the function of child creation and nourishing. It is obvious that if this energy, instead of being used for the process for which it was designed, be diverted to another process, the organs which were created for and adapted to the original process will undergo a change comparable to rust. That is, they will no longer be able to perform their special task as easily or as successfully as if the energy supplied to them had never been diverted to perform other tasks of a different nature. Now, when the supply of energy which nature has prepared for the biologic function in a woman is not disposed of through the means provided, but is applied to the performance of other tasks, this woman naturally becomes less and less able to bear healthy, normal children. Under modern social and economic conditions increasing numbers of women are expending the energy intended to be reserved for their vital function in what was formerly considered man's work. It is only natural that such women are likely to bear poor children and thus to add materially to the afflictions of society.

But the problem is not merely one of the mothers' misspent energies and exhausted forces. The emotional side of a woman's life is quite as important a factor in this connection as the physical side. The constant shocks to which a woman is subjected in industrial and business life have the effect of upsetting her glands and nervous system.

A

B



C

COMPLETELY NORMALIZED BY TREATMENT

FIGURE 2. At two years of age this child could not stand without being supported (A), and could not talk. After fifteen months of thyroid treatment he is well on his way toward being entirely normal (B). At eleven years of age he is an active and thoroughly normal boy —ahead of his grades at school (C). He is still taking treatment, and will have to do so at regular intervals throughout the rest of his life. He is suffering from a serious deficiency of the thyroid gland, and not from its entire absence, or treatment must have been begun much earlier to have succeeded.

We have already seen what results from such disturbances. It is a fact, well understood by all neurologists, that women are peculiarly sensitive to emotional stresses and to all manner of thrills, fears, and excitements. Woman is by nature more unstable than man. She is ill adapted to the struggle for subsistence and her projection into the vortex of industrial life is daily proving a more and more serious menace to the future of the race.

Successful Treatment of Defectives

Our failure to help such cases as the two described is, however, more than compensated by striking success in instances where the mother has been less gravely disturbed. The extent to which we have been able to normalize cretins and other thyroid cases has certainly not been the least marvel of modern medicine. These types of children form the majority among the offspring of mothers suffering from the milder forms of chemical imbalance of a certain kind. As is well understood, these children are of two types: (a) those in whom the thyroid gland is absent; and (b) those in whom it is undeveloped in varying degrees. In either of these instances it is apparent that the formative activity in the cells of the child has been selectively inhibited, only the thyroid being primarily involved. If the gland is absent, the case is, of course, most serious and early treatment is imperative. If such children can be taken in hand during their first year and the full cooperation of the parent secured to the end that the treatment be constant and continuous, we can now completely correct the conditions by the feeding of the required amounts of thyroid substance. In cases where the gland is merely deficient, good results can be secured even after the child has reached the age of two or three years.

Just here, however, a point of the utmost importance must be understood. Most parents, and, I believe, some doctors, labor under the misconception that endocrine material, prescribed in definite cases of bodily absence or deficiency, may be taken for a time and then discontinued. As a matter of fact, a child with an absent or deficient thyroid must take the required amounts of thyroid substance regularly and without fail for the rest of its life. The evil results of an opposite policy will be seen in Figure 5.

If there is a marked deficiency or total absence of thyroid hormone in a child, the growth of the body, particularly of the brain, bone structure and hair, will be inhibited and the result will be dwarfing, mental deficiency and monstrosity. (In thyroid cases the gonads are not so seriously affected as in cases where there is a deficiency of the anterior lobe of the pituitary.) Consequently, if this condition is not corrected early in life, parts of the brain will simply fail to form, and it is apparent that such lost ground cannot be regained. What has never formed cannot be treated. We cannot build brains. All we offer now is help toward their formation by the introduction of the missing endocrine materials which control their growth.

The happy results of early and consistent treatment of thyroid children will be seen from Figures 2 and 3.

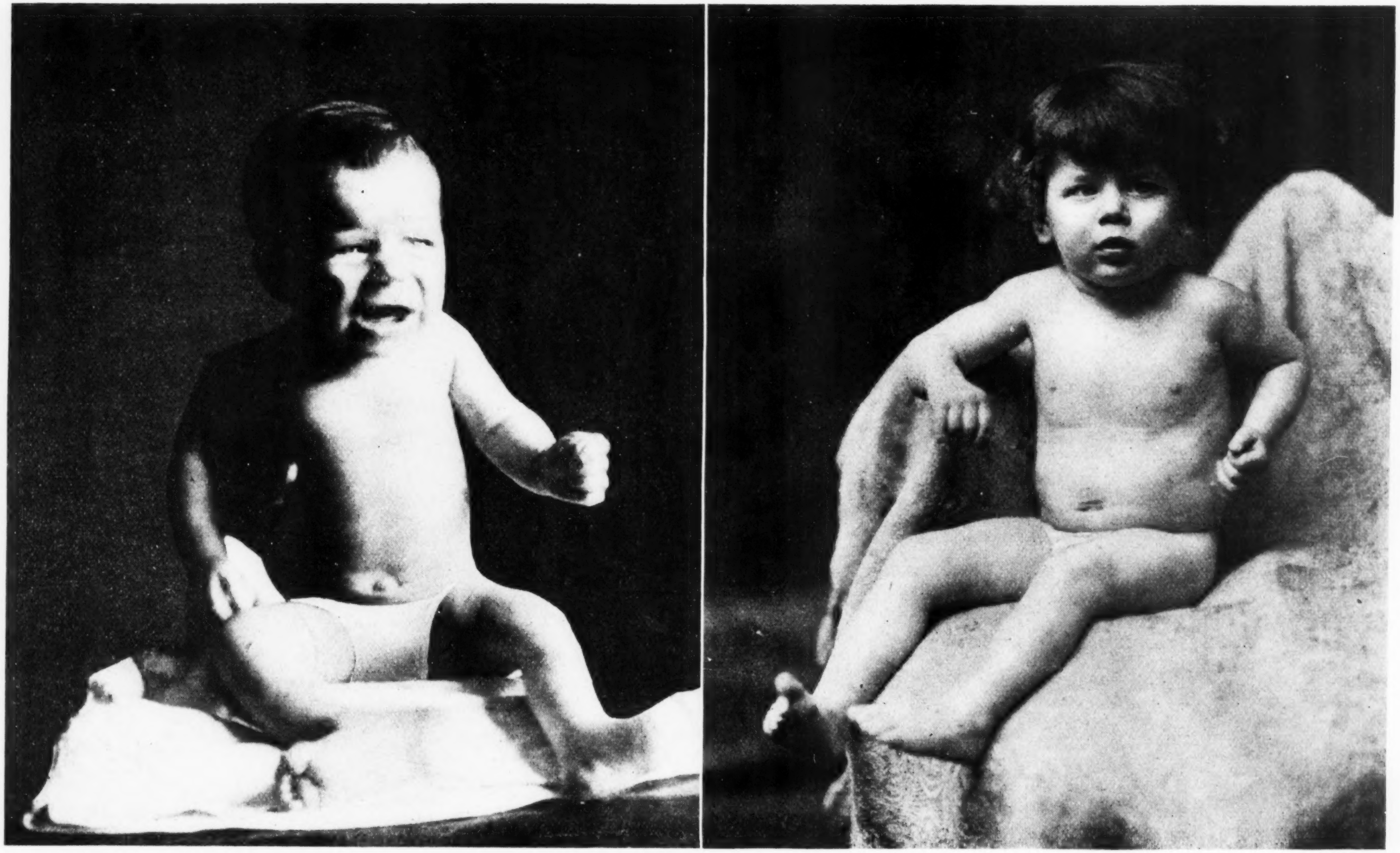
Again in Figure 2, we see the pictorial history of a child suffering from a dangerous hypothyroidism. In Photograph A, we have the child at the age of two; in Photograph B, after fifteen months of treatment; in Photograph C, at the age of eleven years, thoroughly normalized, ahead of his grade in school, keen and active. This boy is, of course, still being treated and he will continue to be ministered to for life. Please note that he suffered from a marked deficiency, and not a total absence, of the gland. Had the latter been the case, he could not have been brought to such excellent health unless treatment had been begun much earlier than the age of two years.

In Figure 3, Photograph A, we have a cretinous child of six months, at which time treatment was begun. In Photograph B, we see the same child at two years, after consistent treatment.

earlier to have succeeded. ment must have been begun much

A

B



THYROID TREATMENT BEGUN IN TIME

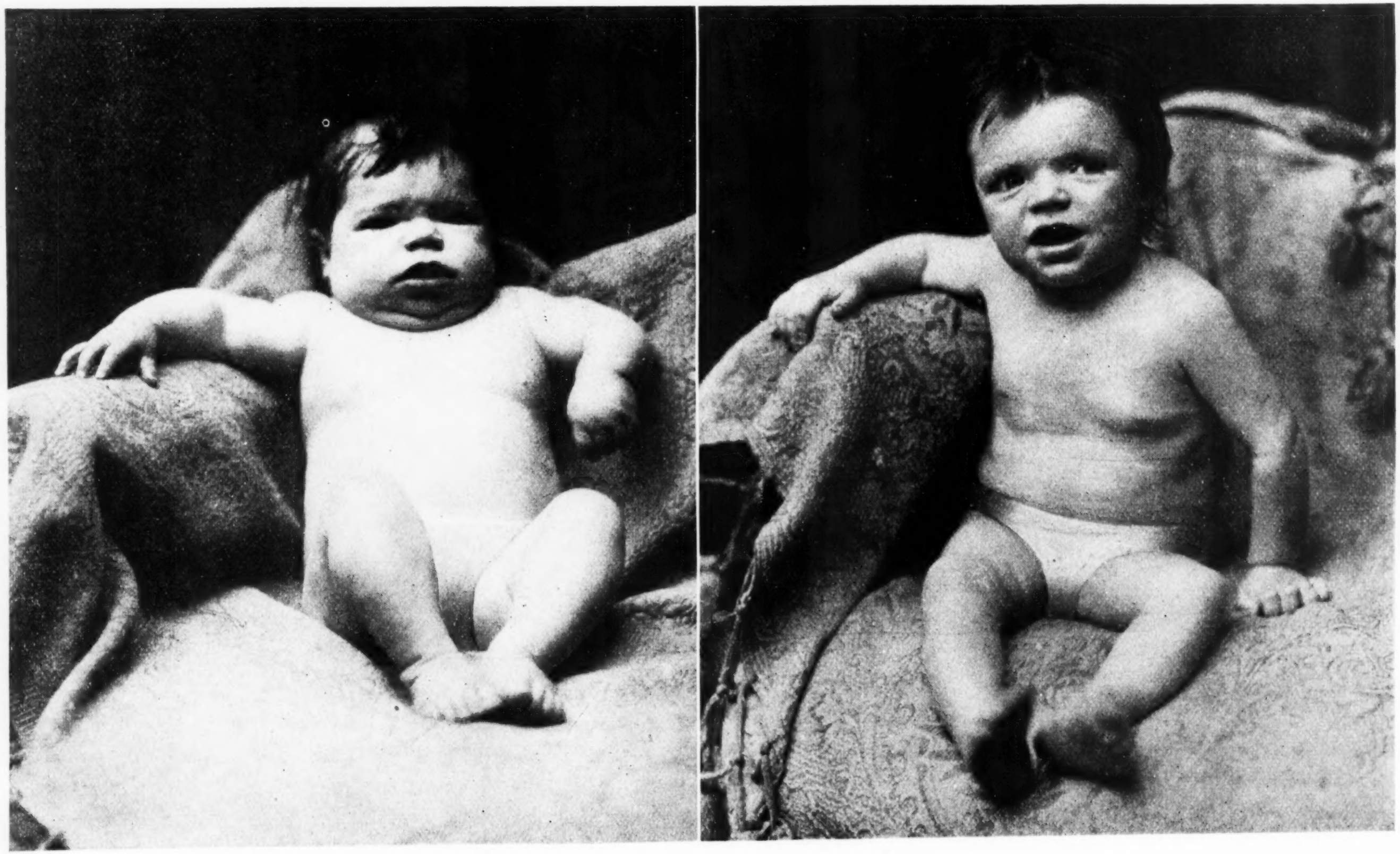
FIGURE 3. This child began treatment at the age of six months (A), and at two years its development is progressing normally (B). Compare with the untreated four-year-old child in the next picture.

A

B

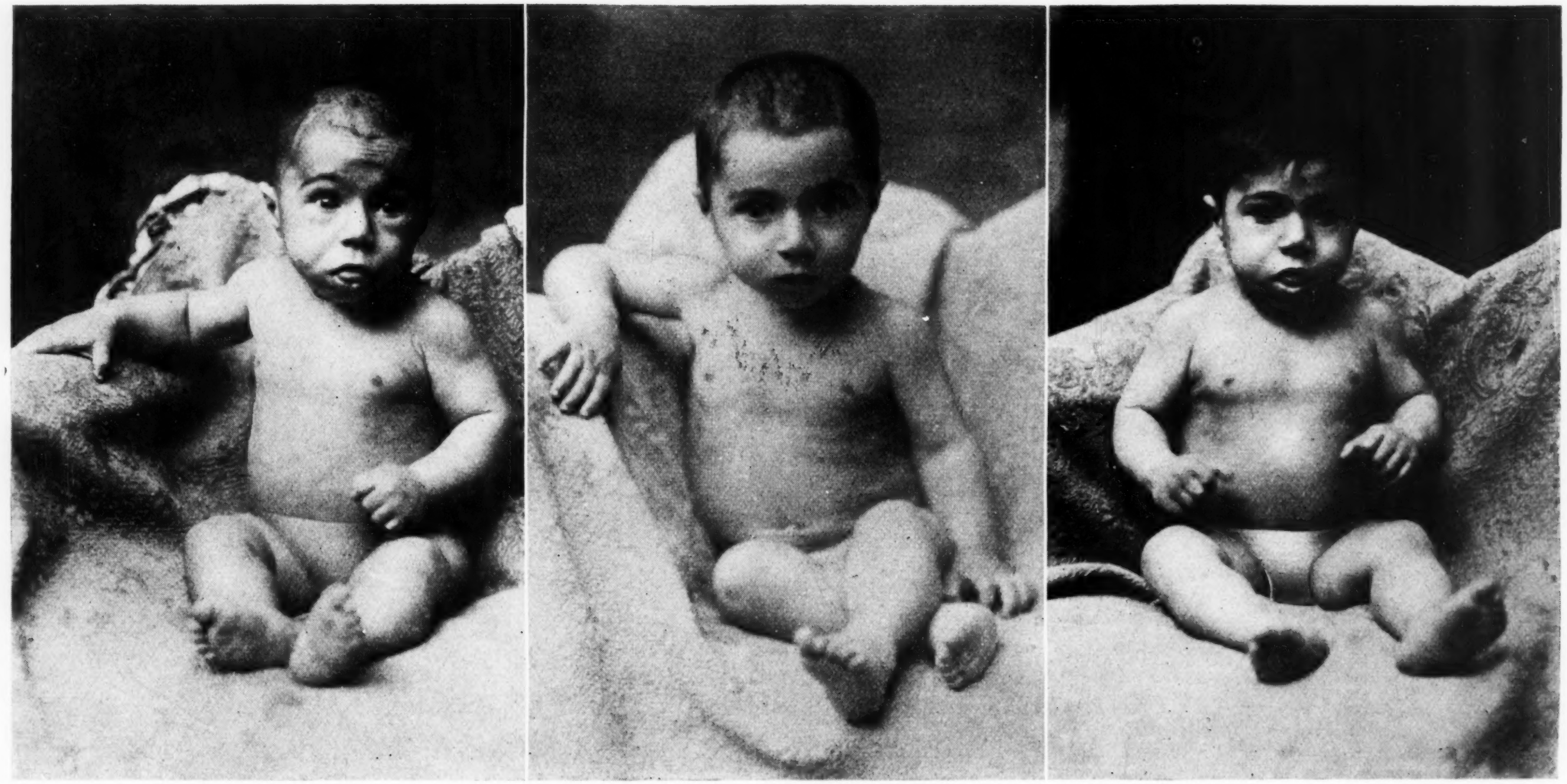
A

B



THE RESULT OF WAITING TOO LONG

FIGURE 4. During the first years of its life this child was treated for obesity, but thyroid substance was not administered until it was four years old (A). Two months later (B) great improvement is evident, but the child can never be normalized. The first four years, during which brain, bones, and hair failed to form properly, can never be recaptured from the past.



Before Treatment | Three Weeks of Thyroid Treatment | Treatment Discontinued Six Months

FAILURE TO CONTINUE TREATMENT SHOWS QUICKLY

FIGURE 5. As a result of thyroid treatment this child was well on its way toward normal development when the parents felt that a cure had been affected, and withdrew it from medical care. Six months later the child had nearly returned to the condition from which proper treatment had saved it.

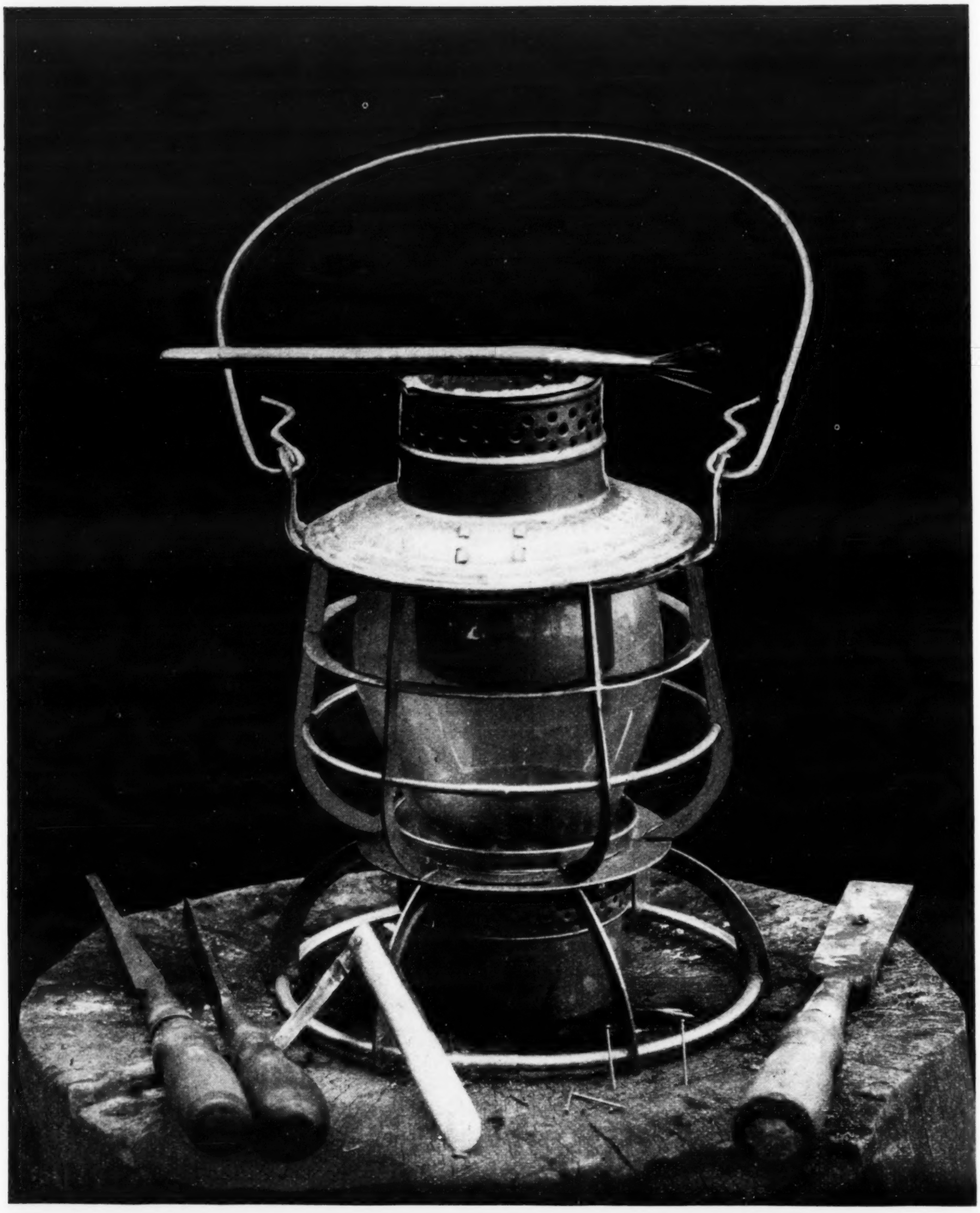
To illustrate this point, let us glance at Figure 4. Here is a child which was brought to me at the age of four years. It has been treated elsewhere for obesity, with the result of harm, instead of help. The thyroid gland is most seriously involved in this unfortunate. Photograph A shows the child as it appeared when brought to my clinic. Photograph B shows the same child after six weeks of treatment This child will be considerably helped, but there is no hope of normalizing it. The four first years, during which its brain, bones, and hair failed to form properly, cannot be recaptured from the past.

My intention, in this article, has been to contrast such feats of treatment as are now within our power, with the infinite mysteries still to be explored. It is clear beyond peradventure—or so it seems to me—that to disturbances of the chemical balance in the blood of mothers we will be able to trace far the greatest number of all cases of physical and mental malformation in children. It is even possible that more extensive investigations will widen the horizons in this field, and that we shall find this disturbance in the body of the mother directly responsible for faults and weaknesses in the child, whose connection with such disturbance has as yet been unsuspected.

The problem which stands immediately before us, however, is to gain such understanding of other gland involvements in children as we now possess in the matter of thyroid cases. We know full well that the pituitary gland is involved in certain of these pitiful malformations of human beings. We know, less certainly, that the suprarenals, the pineal, the interstitials and the thymus also play their parts. But to date we have not been able to determine the precise nature of their influence or of the disturbances to which they are liable. Still worse, in cases where we have been able to guess at the involvement of these other endocrines, we have been unable to treat the condition effectively. The task which confronts us, therefore, is to explore both the nature of the disorders due to the derangement of other glands, and the manner of administering the missing hormone substances. As yet we can do the latter with full success only in thyroid cases.

It seems to me that our total energies ought to be brought to this work of research, in the laboratory and in the clinic. We must lay less stress upon devising mentality tests and the like, which deal merely with the symptomatology of the subject; and we must devote ourselves whole-heartedly to the quest after the etiology of these terrible and grotesque afflictions. Such tests are of unquestioned value in the diagnosis and classification of mental abnormalities, but to look to them for light upon the prevention and treatment of these conditions would be to place ourselves in the position of general medicine in the middle of the last century when symptoms, instead of causes, were being treated—and with what lamentable results! It is obvious that no amount of education of function can remedy ills dependent upon malformation of the essential machinery of the human mind; neither can it supply any of the missing chemicals which furnish the necessary food for this machinery.

The way lies straight, it seems to me. We know the general causes of most defectiveness and malformity. Our duty is to search out the specific causes for each form known to medicine. Once this etiology is in hand it will be but a step to devise practical methods of operation.



SOME OF THE TOOLS USED IN "SLOT GRAFTING"

FIGURE 6. The most important is the "Merrybook Melter," an ordinary railroad lantern with a deep cup fitted into its top for holding melted parafine, and an alcohol lamp in place of the kerosene burner of the lantern. Chisels, brads, and stout knife are the other requisites. (Photographs for Figures 6-11 by Robert Cook and the author).

A NEW METHOD OF GRAFTING

Modification of the Morris Proximal Slot-Graft Successful With Plants Not Heretofore Grafted—Method of Value To Plant Breeders

T. RALPH ROBINSON

Bureau of Plant Industry, Washington, D. C.

THE experimenter with woody plants is confronted with the problem of propagating the superior varieties that he produces. Any improvements of existing methods of budding or grafting should therefore be of direct interest and importance to plant geneticists, as well as to plant lovers and horiculturists, both amateur and professional.

A method that has a number of advantages over those generally used has been developed recently. It would appear to have a wide application, and it is hoped that the brief description which follows may lead to further experimentation and improvements.

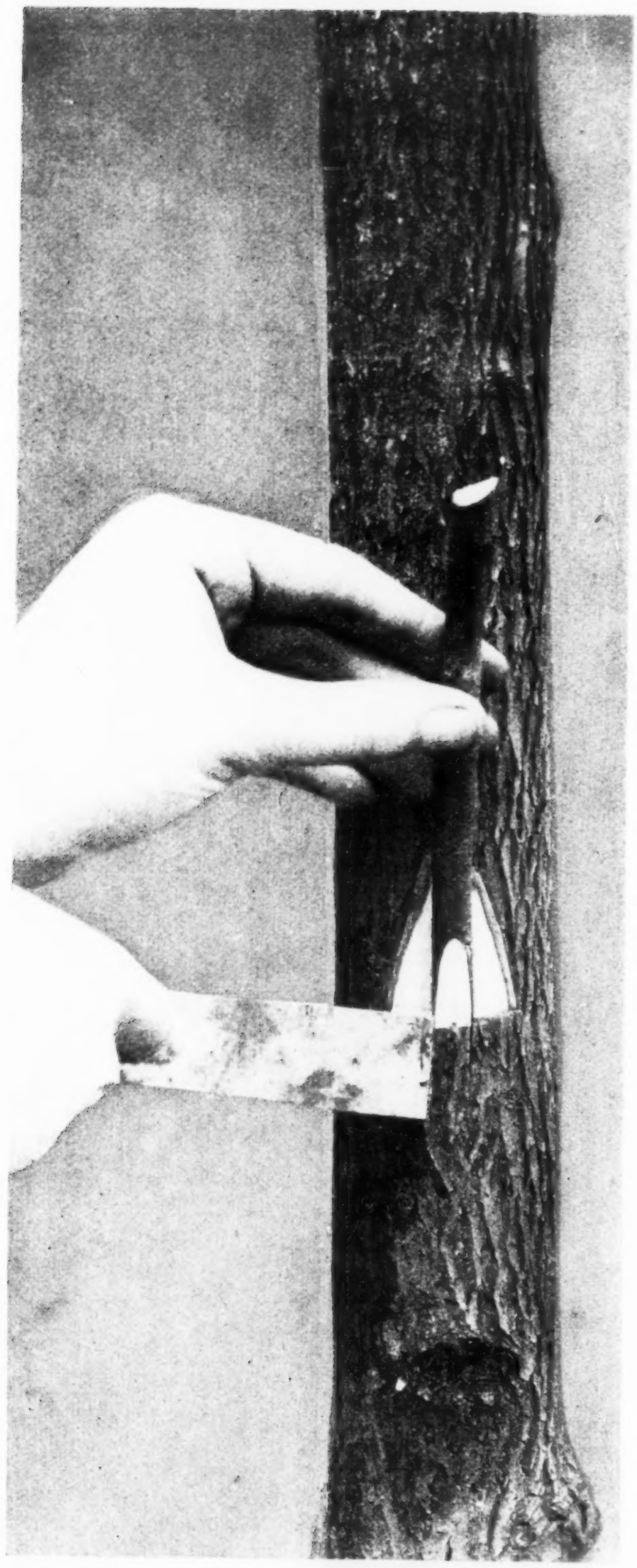
Dr. Robert T. Morris, in his book on "Nut Growing," describes a method he has used with considerable success in grafting nut-bearing trees. He calls it the "proximal slot-graft." Besides the technique involved in the method of inserting the graft, a vital part of the process is the use of melted paraffin as a covering instead of the usual grafting wax. Dr. Morris also lays considerable emphasis on some ingenious methods of wrapping, when working with nut trees.

The Morris method in its main features has been tried out during the past year in Florida on subtrophical fruit trees, chiefly citrus, avocados, and mangos. Mr. James W. Barney, of Palma Sola, Florida, was the first to demonstrate the success of grafting with the aid of paraffin, using the slot-graft method. He modified Dr. Morris' procedure, however, and simplified the technique very materially by doing away with all wrappings, substituting for them a fine brad driven through the graft into the wood of the tree. Besides insuring a close contact not easily disturbed, it permits the paraffin covering to be applied in the most thorough and effective manner—a somewhat more difficult operation when a complicated wrapping is used.

At the April (1923) meeting of the Florida State Horticultural Society, at Orlando, Mr. Barney gave an account of his preliminary experiments. Since then others have been using this method with similar results. The writer has been in touch with Mr. Barney's work and has had sufficient experience in the use of the method to feel sure it can be used to advantage in working over many kinds of fruit trees. Mr. Barney has even succeded in grafting guavas, which is usually regarded as impossible.

The accompanying photographs are designed to show only the main steps in the process of inserting the "proximal slot-graft," some of the more obvious operations not being shown.

First, a cut is made with a chisel or gouge downward and penetrating slightly through the bark into the wood of the stock. A transverse cut is then made at the base of the first cut, providing a shallow niche, with a slight shelf at the bottom (Figure 7). The exposed surface is immediately painted over with melted paraffin, just warm enough to stay in a liquid condition. The paraffin brush should first be tried on the hand; if it proves hot enough to burn, it should be cooled off before using. The graft should then be prepared by tapering to a wedge shape, one side of the wedge longer than the



MARKING AND CUTTING THE "SLOT"

FIGURES 7 AND 8. A notch is cut in the stock so that the shelf at its base is at the point selected to insert the graft. The exposed surface is immediately coated with melted paraffin. Next, the chosen piece of grafting wood is prepared by cutting its base to a wedge-shape. The graft is then used as a guide in making two parallel cuts in the bark of the stock, downward from the base of the notch (Figure 7). The tongue of bark between the two cuts is then lifted carefully with a narrow chisel, but not removed (Figure 8).

INSERTING THE GRAFT

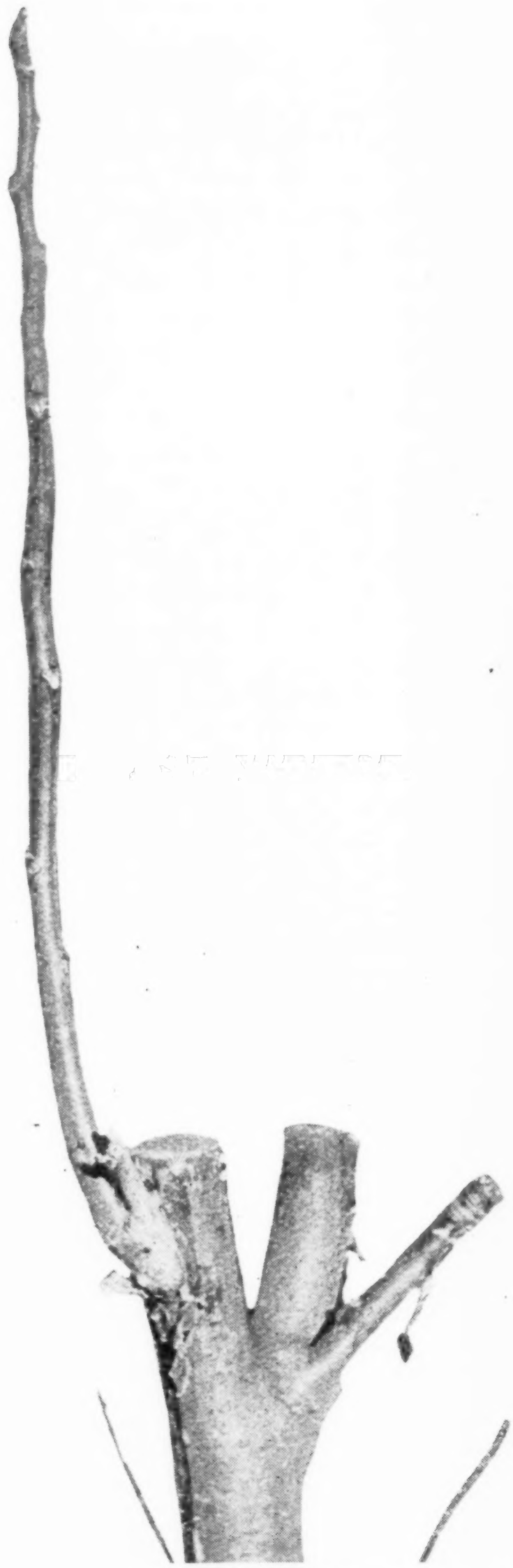
FIGURE 9. The prepared graft is then inserted in the "slot"—with the longer edge of the wedge next to the wood. When the graft has been forced gently but firmly into place a fine brad is driven through both bark and graft into the solid wood.

THE FINISHED GRAFT

FIGURE 10. After the brad is in place all exposed surfaces, and the entire graft as well, are carefully covered over with melted paraffin, which must be fluid, but not hot enough to injure the delicate cut surfaces.

ENLARGED VIEW OF GRAFT

FIGURE 11. This shows the completed graft before it has received its coating of paraffin. If stock and scion have been well chosen, and a good contact secured between them, the only other attention necessary is to cut back the stock and force the graft into growth after a good union is apparent.



TWO EXAMPLES OF SUCCESSFUL SLOT-GRAFTING

FIGURE 12. On the left is shown a Chinese walnut grafted on a butternut on June 20th, 1923, the healthy shoot represents the growth made during the remainder of the season. In some climates the use of a brad to fasten the graft in place has been reported to be unsatisfactory as the iron rusts and becomes a center of infection. The use of a small copper or brass nail has been suggested as a remedy for this. Photograph by Dr. G. A. Zimmerman.

(*Right*)—Mango grafts making rapid growth two months after inserting into the main branches of an old mango tree: an example of the successful application of the slot-graft method by James W. Barney of Palma Sola, Florida. The mass of leaves showing at the top of the picture has all been produced by the two-months-old grafts.

other, but with the sharp end of the wedge about the middle of the diameter of the stick. The graft selected should have two or more good buds above the tapered portion. The cuts made should be smooth and continuous, which requires a strong sharp knife and a steady hand.

The next step is to measure off and mark the width of the graft on the cross cut on the small shelf just described. With a knife or chisel, two vertical parallel cuts are then made downward from the cross cut just deep enough to go through the bark, the cuts being made about as long as the tapered end of the graft. Care should be taken that these cuts are only just wide enough apart to allow the graft to slip into place (Figure 7).

The tongue of bark lying between these cuts is then gently lifted (Figure 8), using a bone or chisel of appropriate width.

The prepared graft is then gently but firmly inserted in the "slot" thus prepared—placing the long cut of the tapered end next to the wood of the branch or trunk of the tree. When pushed down to a good fit, the raised tongue of bark is held firmly against the inserted graft and a fine brad (No. 18 gauge) is driven through the bark and graft into the solid wood. This brad is placed near the upper end of the tongue of bark (Figure 11). Melted paraffin is then applied with a fine brush so as to cover all exposed surfaces and fill every crevice, at the same time applying a light coating over the entire surface of the graft itself. The job is done. If a good contact is secured and stock and scion are reasonably well chosen, the only further attention needed is the cutting back or girdling of the top to force the scion into growth after a good union is apparent.

When ants or bees are active the paraffin covering may need renewing before the union is entirely safe. If exposed to hot sunlight, shading may be necessary. Brads of three-quarter inch length are usually about right, although several sizes may be carried along for different sized grafts. The new growth starting from the graft should be tied up securely to appropriately placed supports.

One accessory invented by Dr. Morris has made this method really practical for the orchardist, namely, the "Merribook Melter." As shown in the photograph (Figure 6), this paraffin melter simply is a lantern with a cup set in the top to hold the paraffin. An alcohol burner is used in the base, having a small wick that can be turned down to mere point of flame, thus rendering it easy to keep the paraffin in a melted condition, but not too hot. The lantern can be hung in the branches of a tree or set on the ground without danger of upsetting. Any of the common paraffins used in preserving, as "Para wax," "Gulf wax," have a sufficiently low melting point to be suitable for covering grafts. Paraffin being translucent, allows the chlorophyll in the bark of the graft to continue functioning and may assist in bringing about a prompt union between stock and scion. Adding three to five per cent of Carnuba wax to the paraffin causes it to flake off when growth starts, and prevents sun scalding.

As in all successful grafting operations, good workmanship is essential, but with average care the paraffin method will give results considerably in advance of the older methods and can be learned by novices with little difficulty.

The topworking of old fruit trees has always offered somewhat of a problem, particularly as to choice of method. Practically all methods, however, involve severe cutting back as a preliminary step, with resulting shock and loss of crop and possible failure of buds or grafts even after such heroic treatment. Some method that permits the retention of the top until after the new graft has taken and started growth has obvious advantages. The wider use of the method should facilitate the reworking of inferior fruit trees to better sorts.

MENDELIAN ANALYSIS OF THE PURE BREEDS OF LIVESTOCK

II. The Duchess Family of Shorthorns As Bred By Thomas Bates

SEWALL WRIGHT

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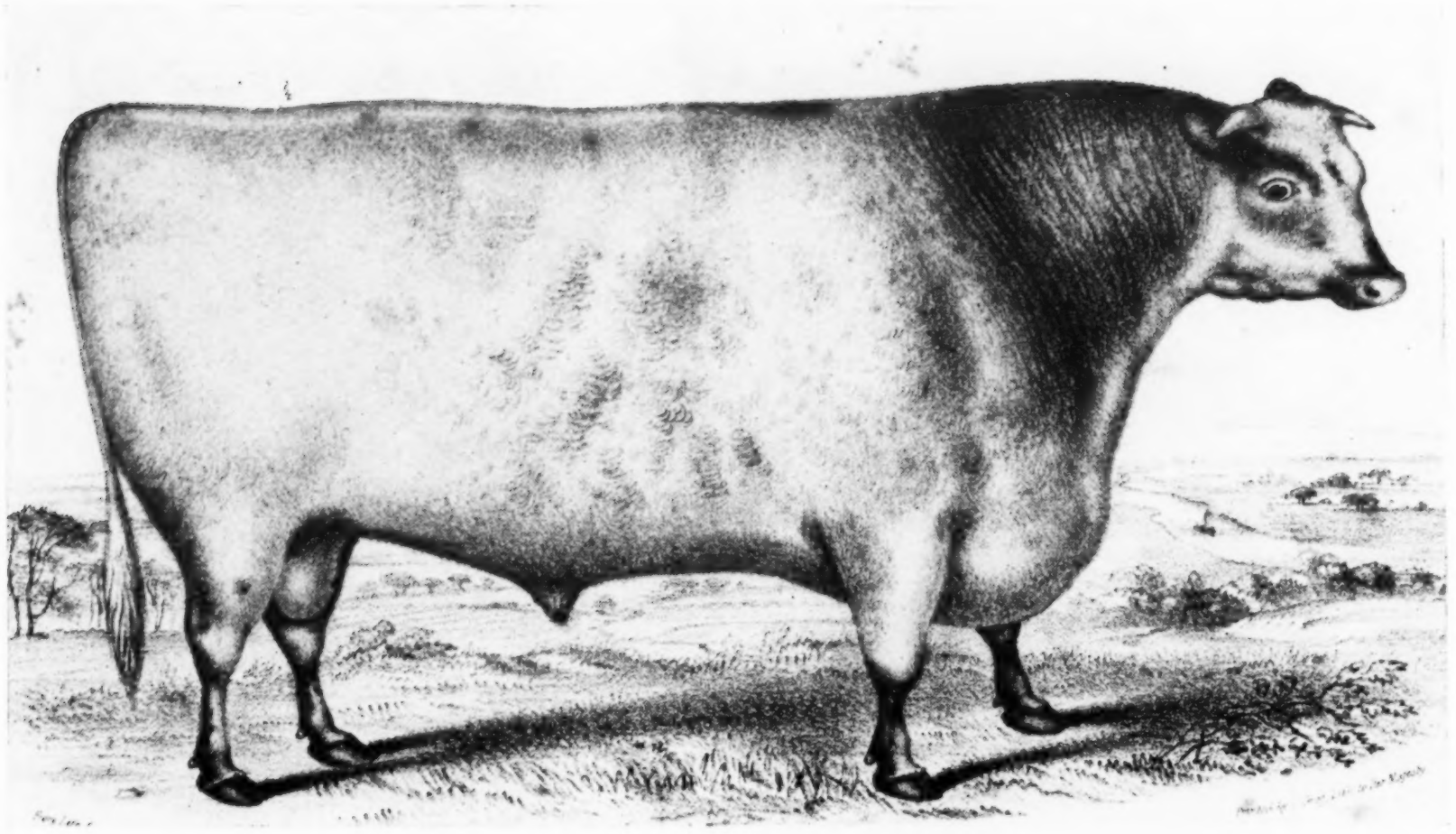
A VARIETY of cattle with short horns and red, roan, and white as the prevalent colors had long been established in parts of Durham, Yorkshire and surrounding counties in England and had been bred to a fair degree of excellence by the middle of the eighteenth century. They have been described from contemporary accounts as "generally wide-backed, well-framed cows, deep in their forequarters, soft and mellow in their hair and handling and possessing, with average milking qualities, a remarkable disposition to fatten. Their horns were rather longer than those of their descendants of the present day and inclining upward. The defects were those of an undue prominence of the hip and shoulder point, a want of length in the hind quarters, of width in the floor of the chest, of fullness generally before and behind the shoulders, as well as of flesh upon the shoulder itself. They had a somewhat disproportionate abdomen, were too long in the legs and showed a want of substance, indicative of delicacy, in the hide. They failed also in the essential requisite of taking on their flesh evenly and firmly over the whole frame, which frequently gave them an unlevel appearance. There was, moreover, a general want of compactness in their conformation." This foundation stock was thus decidedly open to improvement. In fact, Robert Bakewell of Dishley, whose leadership in the improvement of cattle and sheep we have already mentioned[2]* is said to have kept a few of the old sort merely to set off his improved Longhorns.

The foundations for the improvement of the Shorthorns were laid by Charles Colling of Ketton farm, who made a prolonged study of Bakewell's methods at Dishley in 1783. In the following year he bought, among other cattle, a massive, short-legged, wide-backed cow named Duchess, who became the progenitress of the family which we are to study. Meanwhile Robert Colling, a brother of Charles, purchased the bull Hubback, who came to be considered the best Shorthorn bull of the time. One of his grandsons was the noted bull Foljambe. Charles Colling seems to have been sufficiently impressed with the merit of the produce of Foljambe to begin efforts at fixing their qualities by inbreeding. A daughter, Phoenix, was bred to a son, Bolingbroke, and produced (in 1793) the bull Favourite, whose pedigree we have already considered. Favourite was inbred to a very appreciable extent ($F = 19.2$ per cent), not only through Foljambe but through his granddams, one of which was the dam of the other. He is described as "a large massive bull of good constitution with a fine bold eye, remarkably good loins and long level hind quarters." Mr. Colling was so satisfied with Favourite that he began breeding him to his daughters and granddaughters, in some cases even for five or six generations. Through the demand for

*For numbered references see "Literature Cited" at end of article.



DUKE OF NORTHUMBERLAND

FIGURE 13. Bates is considered to have won his greatest triumph as a breeder in producing the Duke of Northumberland (1940) from a mating of Duchess 34th with her own sire, Belvidere.* Duke of Northumberland won first prize at the Oxford Royal Show of 1839 and was generally conceded to be the best bull in England in his time. Without taking the old lithographs too seriously, we may infer from them that Bates was aiming at a compact build, smoothness, and great fineness of bone, and that he came near achieving his ideal in Duke of Northumberland.

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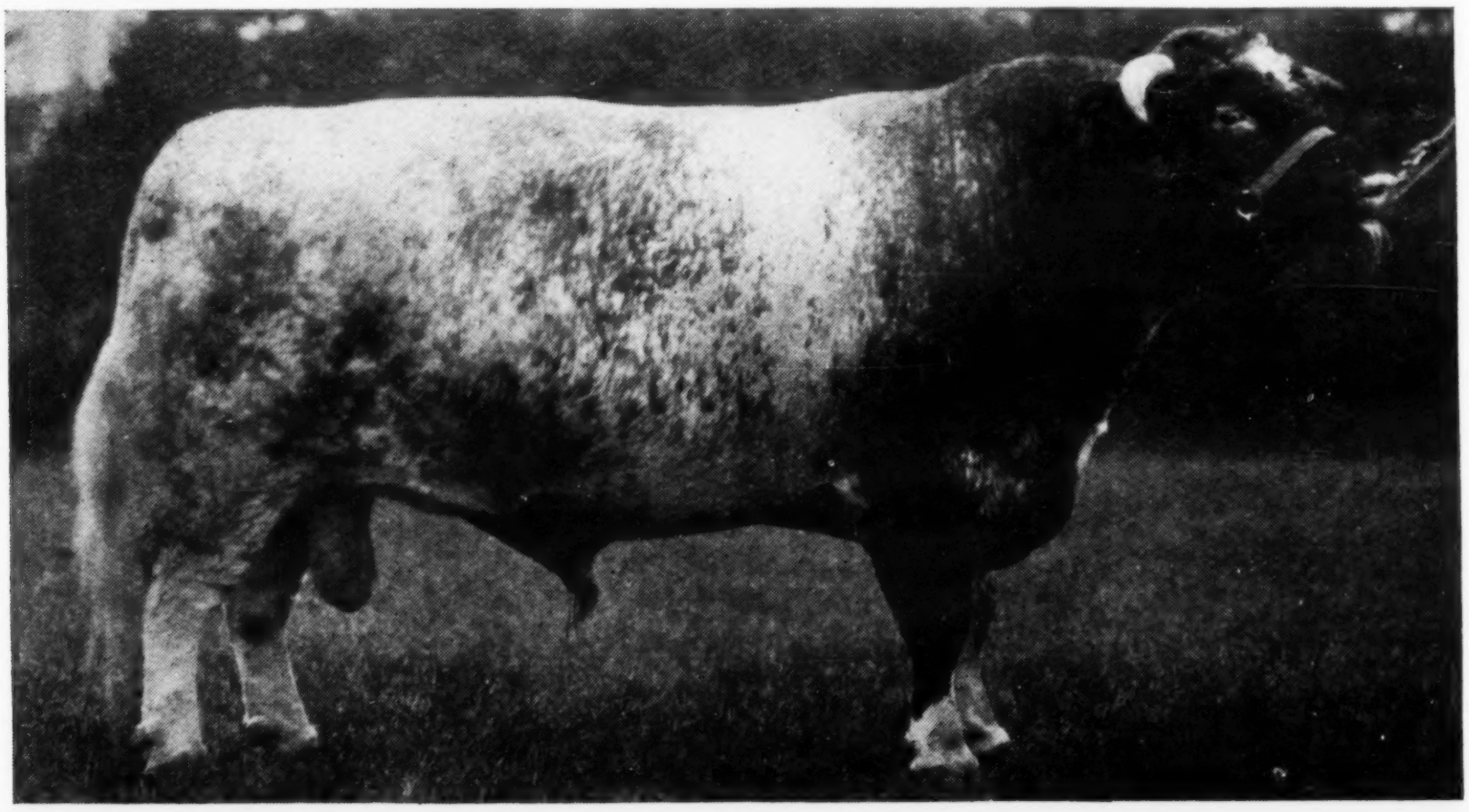
*Correct spelling **Belvedere.** Error in spelling this name noted just before going to press, and too late to change.



A PRESENT DAY SHORTHORN CHAMPION

FIGURE 14. A comparison between the photograph of this bull and the lithographs of the Bates' cattle brings out the greater ruggedness of type that has come into favor, even after due allowance is made for the obvious exaggeration of the old illustrations.

bulls of Colling's improved stock, his blood undoubtedly became more widely distributed in the developing breed than that of any other one animal. Darwin[1] cites his case as an illustration of prepotency. As we shall see, Bates maintained a coefficient of relationship to Favourite of about 60 per cent in his Duchess family for forty years after Favourite's death (in 1809).

At the dispersion sale of Charles Colling's herd, in 1810, forty-seven head, all by Favourite or his son Comet or their get, sold for £7,115, an unprecedented amount. The record price, 1,000 guineas, was paid for Comet, a son of Favourite, dam by Favourite and out of Favourite's dam. This remarkably inbred animal (F = 47.1 per cent) was declared by Mr. Colling to be the best bull he ever bred or saw. For years after, it seems to have been the general opinion that no Shorthorn bull had ever been quite the equal of Comet. Mr. Colling's stock are described by a contemporary, as of great size and substance, fine long hind quarters, space from hip to rib long and counteracted by a broad back and high round ribs.

The Duchesses

One of the bidders at this dispersion sale was a young breeder, Thomas Bates, who had made a careful study of cattle pedigrees. He purchased a rather "shabby" cow called Young Duchess, largely, it appears, on the strength of her pedigree, her top sires being Comet, Favourite, Daisy Bull (a son of Favourite), Favourite again, and Hubback. She was a descendent in the straight female line of the cow Duchess purchased by Charles Colling in 1784. Following the custom of naming families by the female line, Bates developed a Duchess family from this cow, which he renamed Duchess I. Up to the time of his death in 1849 he had bred sixty-three cows in the family which he named Duchess 2 to Duchess 64. Two other females are recorded as having died. Forty-five males are recorded as dropped by Duchess cows, twenty-nine of which were named. The family was not a prolific one. They won, however, an extraordinary reputation. The Duchess bull, Duke of Northumberland, which won first at the Oxford Royal Show of 1839, was conceded to be the best bull in England in his time. Bates had other notable successes in the show yard although an opponent of the system of specially fitting for the shows.

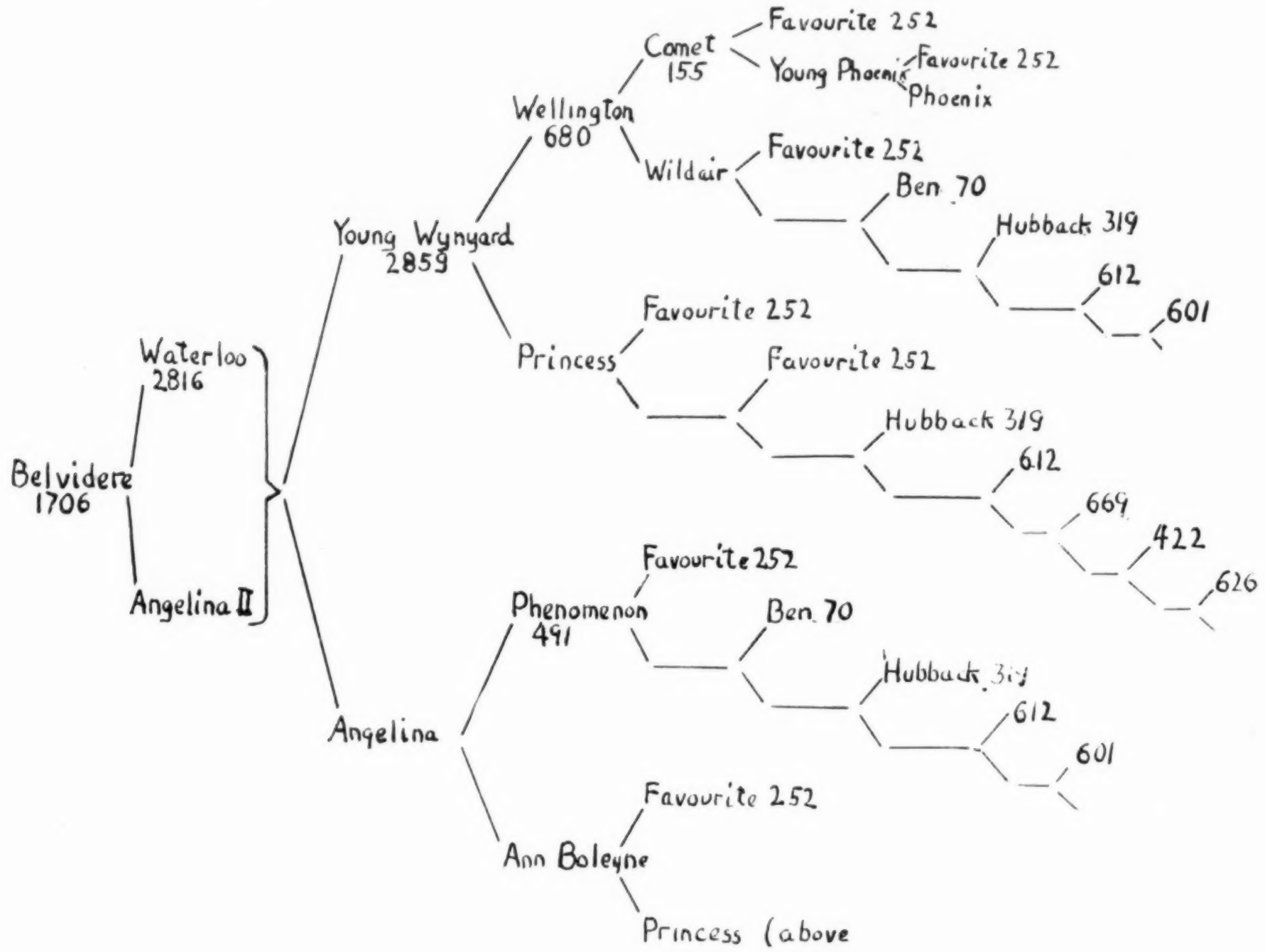
This reputation extended to America and Bates-bred cattle, especially bulls of the Duchess family, played a notable part in the improvement of American Shorthorns.

After Bates' death, a line of Duchesses was maintained without outcrossing. These became the aristocrats of the cattle world. The family had never been a prolific one and became increasingly difficult to maintain as a pure strain. This, however, does not seem to have been held as a detriment but rather the reverse, since it resulted in enhanced values due to scarcity. The climax came in a sale at New York Mills, near Utica, N. Y., in 1873. The "pure" line of Duchesses had become extinct in England and all in America had come into the hands of one man. The sale at New York Mills developed into an international competition for the "pure" Duchesses. One cow sold for $40,600. The average of the eleven Duchess cows was $21,705, that for three bulls was $7,866.

While these prices were largely speculative and the real merit of the family was falling off, in the hands of the speculators as the prices mounted higher, the fact remains that as bred by Bates, the Duchess cattle were a most notable achievement of breeding skill. Through crosses with other lines they have had a conspicuous part in the improvement of the Shorthorn breed.

Description of Tables

The sixty-three Duchesses bred by Bates, and their ancestors in the straight female line are listed in Table II with



THE PEDIGREE OF BELVIDERE

FIGURE 15. The purchase of Belvidere (1706) from Mr. Stevenson is considered to mark the turning point in Bates' career. Note that Belvidere's sire and dam were full brother and sister, making possible condensation of the pedigree as indicated.

their date of birth and the dam and sire of each. The coefficient of inbreeding has been calculated as described[2], for all of these animals and is given in the next three columns. The relationship of the sires and dams of the Duchesses is given in the next column. Finally it is of interest to find how far there was relationship to Favourite, the bull to which the greater part of the inbreeding is due. The last three columns are devoted to this purpose, dealing with the individual and her sire and dam respectively.

All pedigrees have been traced to the beginning of the Coates' herd books in making these calculations. They naturally become very complex after a few generations. The labor in calculating the coefficients is not so great as might be imagined, however, since the calculation of the contribution to inbreeding or relationship made by two animals on opposite sides of a pedigree can be used in all other pedigrees in which these same animals appear on opposite sides. In the course of the work a list was made of the contributions due to the various important sires with each other and with the more important cows. The parentage of the sires is given in Table I. It will be noticed that all but four of the twenty-five of them were from sires that appear earlier in the list and that eleven of them were from Duchess cows. The pedigrees can be practically completed by reference to the notes and to the pedigrees of Favourite[2], 2nd Hubback, Belvidere, Gambier and Norfolk (Figures 15-18).

Relationship of Sires and Dams

The results are summed up in Table III by generations and are presented graphically in Figures 21, 24 and 25. Duchess 59 and 62 were eight generations from Duchess I, and thirteen generations from the original Duchess purchased by Charles Colling in 1784.

The coefficients of relationship between sire and dam are given in Figure 21. For three generations there was little or no relationship. For Duchess by Daisy Bull in the next generation the coefficient rises to 39 per cent, both sire and dam having been progeny of Favourite. The parents of Duchess by Favourite and Duchess I (by Comet) in the next two generations show coefficients of 53 per cent and 59 per cent respectively. These figures are to be compared with coefficients of 50 per cent between ordinary brothers and sisters or between parent and offspring in a random-bred stock. They measure the actual correlation in appearance in characters which are wholly determined by nondominant genetic factors. They are doubtless about what the reader would expect from a cursory examination of the pedigrees.

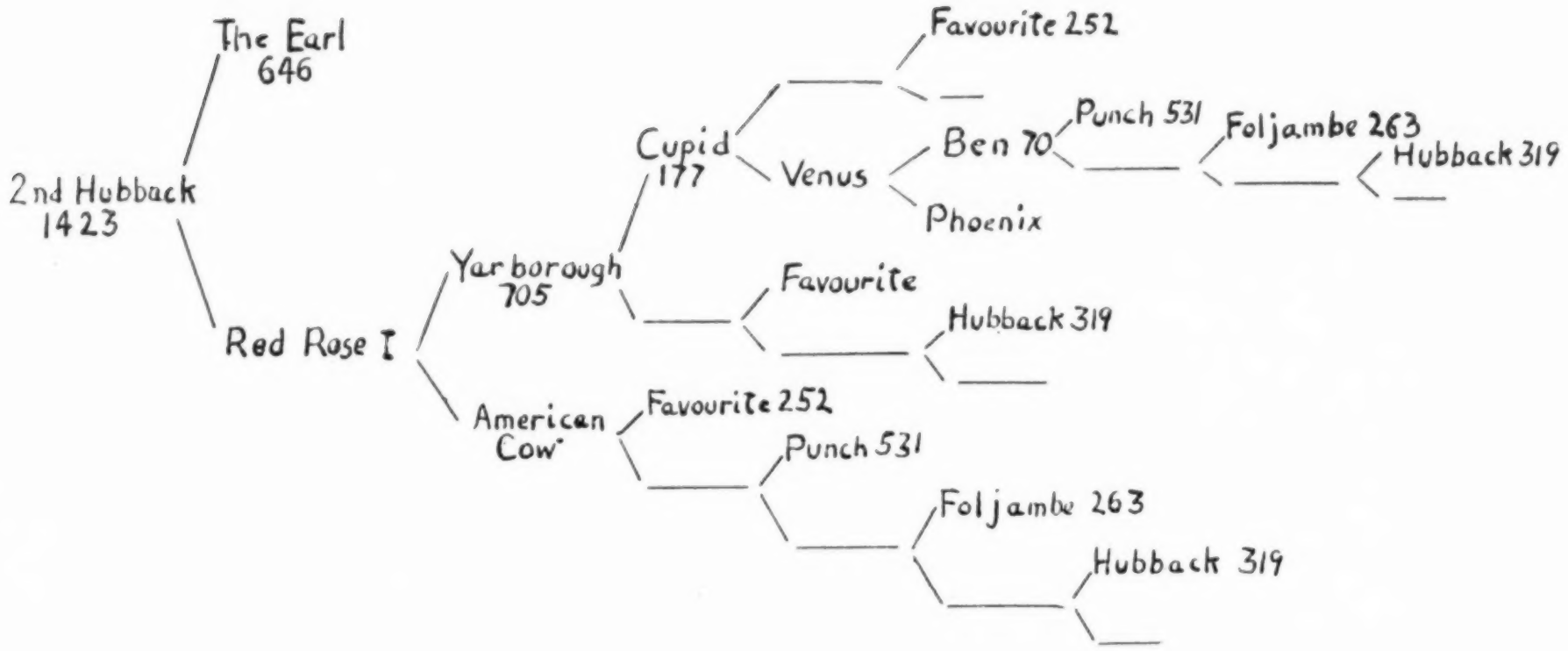
It is not so obvious, however, what the correlations in later generations should be. The general opinion has been that Bates began his career with very intensive inbreeding and on encountering deterioration was obliged to make outcrosses. Darwin[1] states, "For thirteen years he bred most closely in-and-in; but during the next seventeen years, although he had the most exalted notion of his own stock, he thrice infused fresh blood into his herd; it is said that he did this not to improve the form of the animals, but on account of their lessened fertility."

The calculation of the actual relationships of the sires and dams, however, shows no such history. The sire and dam of Bates' purchase, Duchess I, were correlated about 0.59 ($R = 59$ per cent) on account of relationship. During the eight generations bred by Bates, he practically maintained the same level of relationship, the coefficients fluctuating about 60 per cent. The parents of the ten cows of the second generation after Duchess I were correlated 0.67, the high point, while the parents of the nine cows of the fifth generation were correlated only 0.52 at the other extreme. The average for the next generation, however, was 0.64 and the eighth generation averaged 0.63. Turning to individuals, the high point was reached in the mating which produced Duchess 21, where the coefficient is 87 per cent. The low point was reached in Duchess 41, where it was 42 per cent.

The purchase of the "Princess" bull Belvidere is generally given as the turning point in Bates' career, the point at which he found it necessary to introduce fresh blood and the point with which his greatest success began. It is true that Belvidere had no Duchess blood. He was, however, rich in the blood of Favourite as may be seen from his pedigree (Figure 15). His relationship with Favourite was about 65 per cent. In fact his relationship with Duchess 19 and with Duchess 29, the cows of the Duchess family with which he was first mated, were as high as 45 per cent and 47 per cent respectively.

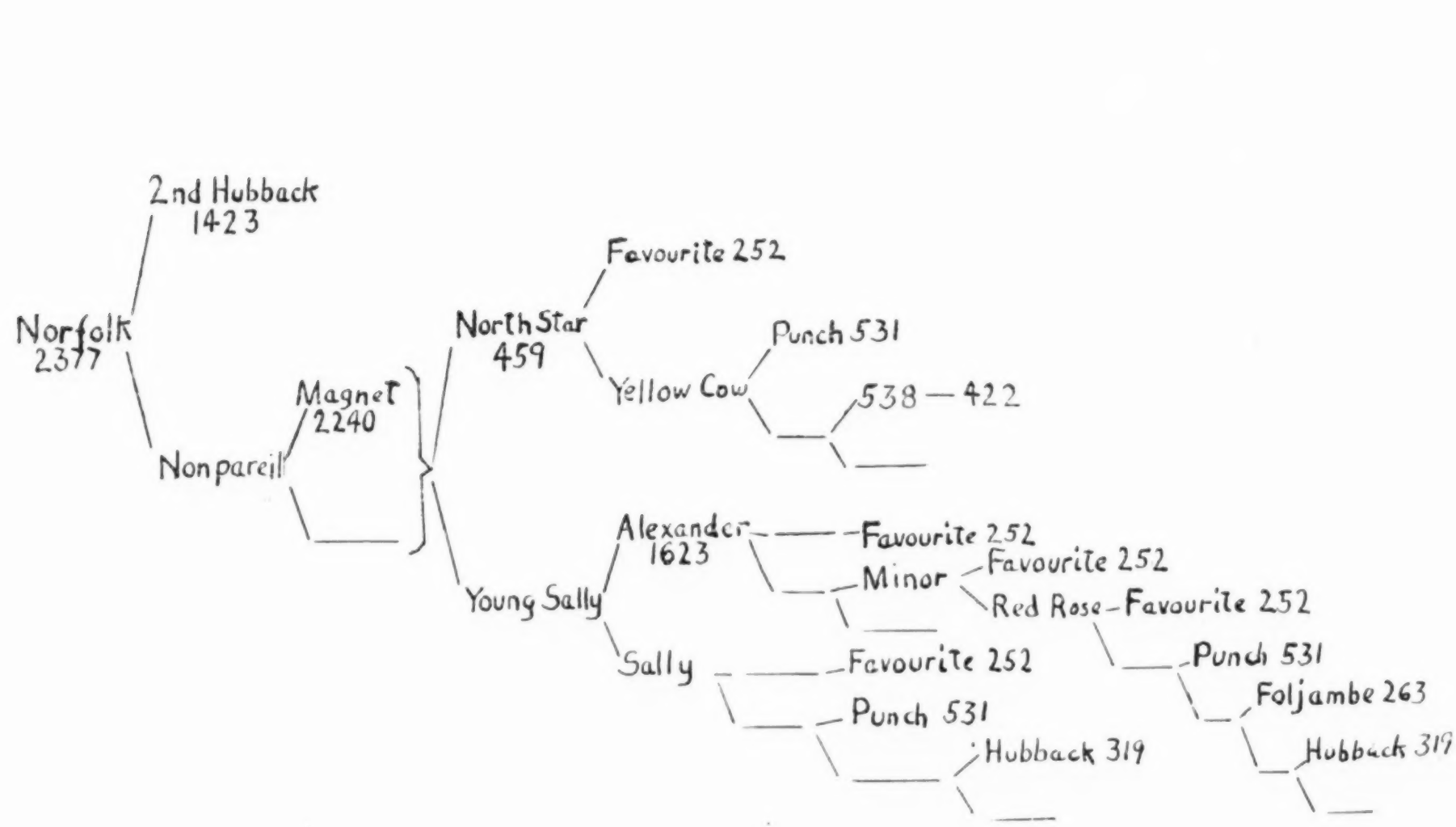
Previous to the use of Belvidere, outside blood was introduced through 2nd Hubback. However, while Red Rose I, his dam, had no Duchess blood, she was closely related genetically (see pedigree, Figure 16). Moreover the sire of 2nd Hubback was the Duchess bull, The Earl. Second Hubback should have shown a correlation of about .65 with Favourite as far as all purely hereditary characters were concerned and correlations .49 and .62 with the first Duchesses with which he was mated.

Fresh blood was introduced later through the bulls Gambier and Norfolk, bred by Jonas Whitaker, which were without Duchess blood on either side of their pedigrees (Figures 17 and 18). Nevertheless both of these bulls were closely related to Favourite (65 per



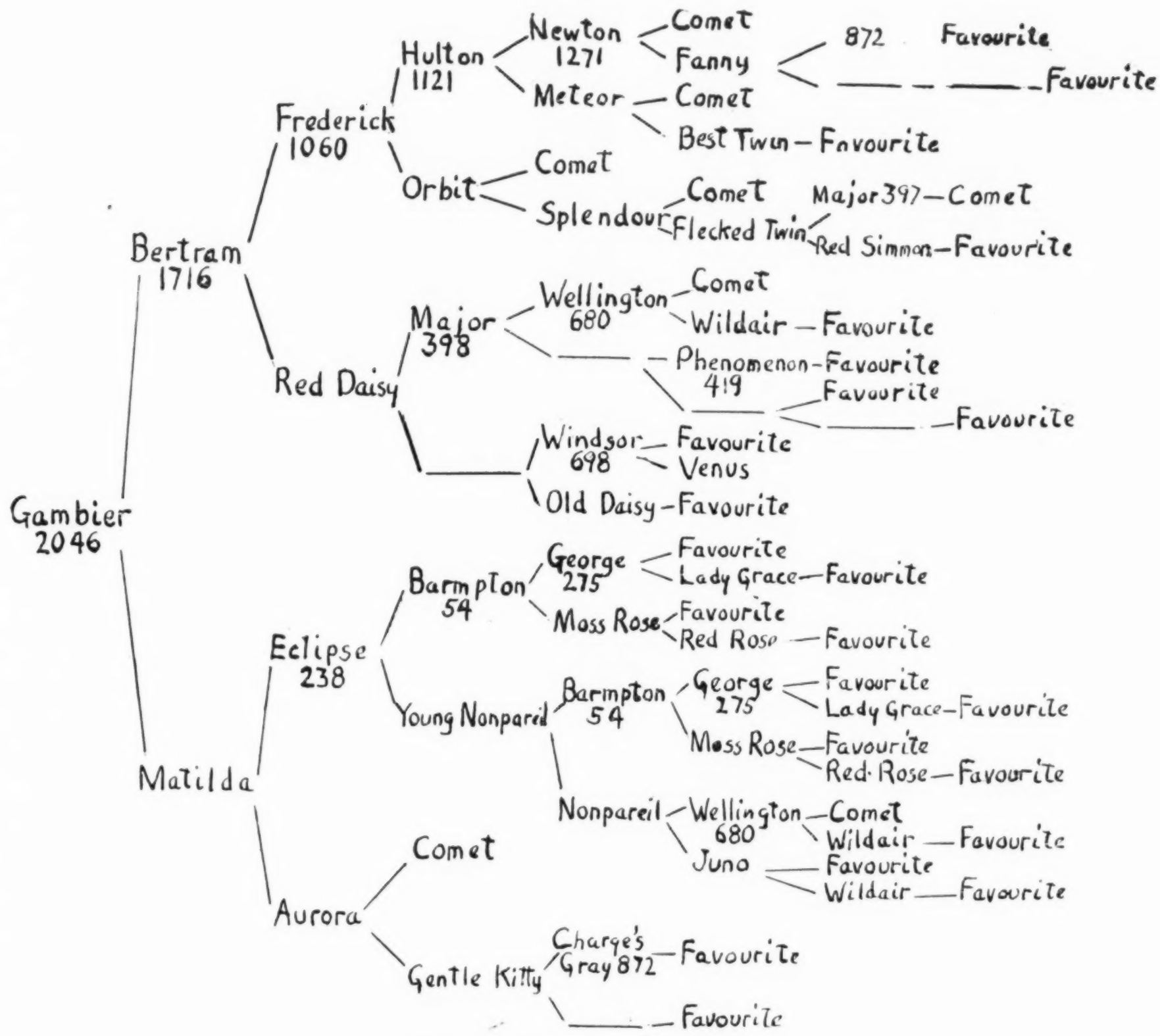
THE PEDIGREE OF 2ND HUBBACK

FIGURE 16. Second Hubback (1423) was one of the bulls used by Bates to keep the degree of inbreeding in his Duchess herd from rising too high. The pedigree of 2nd Hubback's sire is given in Table I and is not repeated here.



PEDIGREE OF NORFOLK

FIGURE 17. The bull Norfolk (2377), bred by Mr. Whitaker, had no Duchess blood, but was closely related to Favourite, as the pedigree shows. The pedigree of the sire, 2nd Hubback, is given above, and in Table I and hence is not repeated.



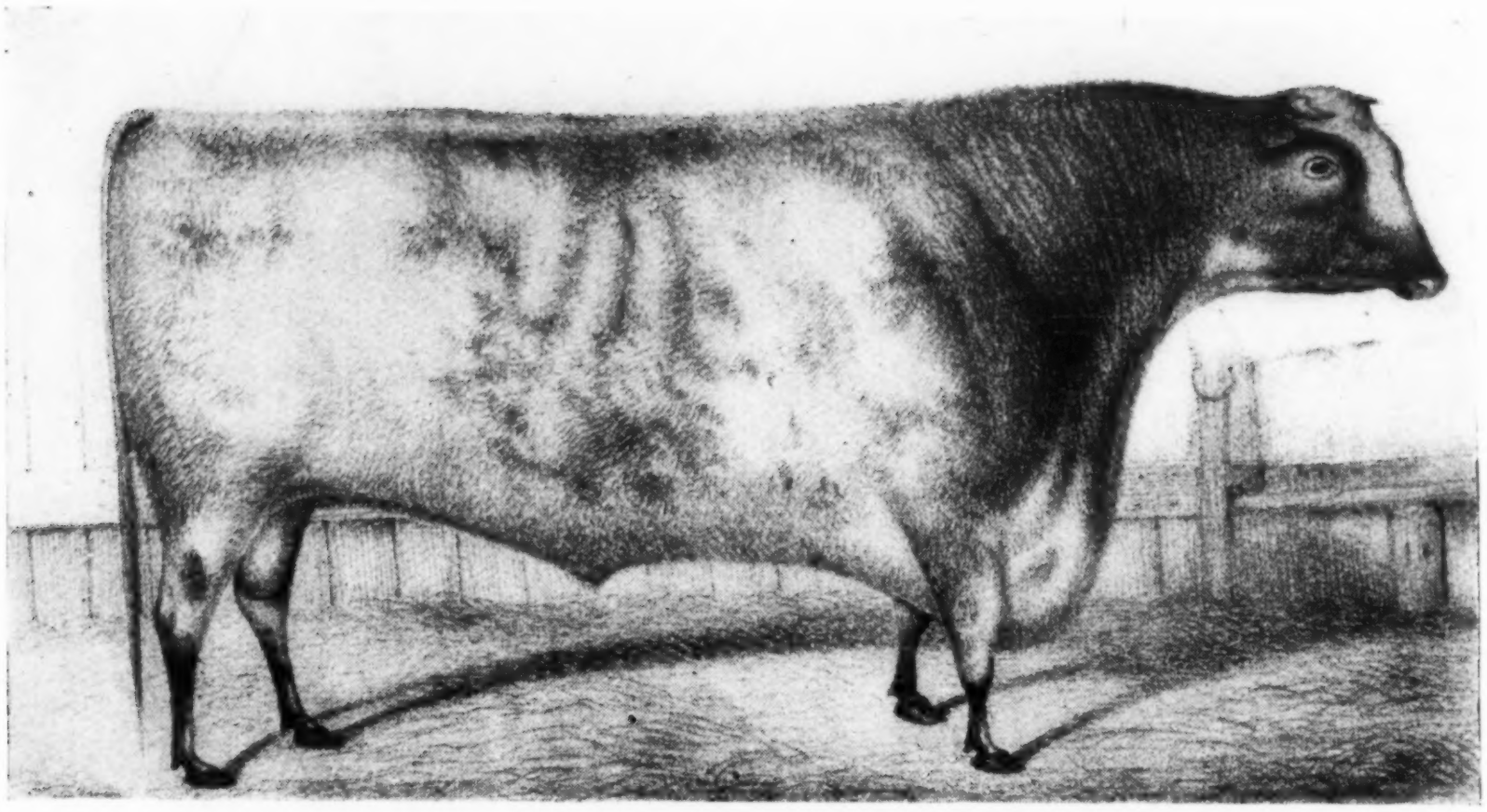
PEDIGREE OF GAMBIER

FIGURE 18. The bull Gambier (2046) was bred by Jonas Whitaker. The numerous lines tracing to Favourite (252) and Comet (155), the son of Favourite, are shown. There are, however, other lines early in the pedigree which trace to the bulls, Foljambe, Dalton Duke, Hubback, Ben, and Punch, and to the cow Phoenix (Dam of Favourite), which are not shown to avoid undue complexity, but are taken account of in calculating coefficients of inbreeding and relationship.

cent and 55 per cent respectively), and both were genetically almost as closely related to the Duchess with which they were mated as ordinary full brothers and sisters (47 per cent and 49 per cent).

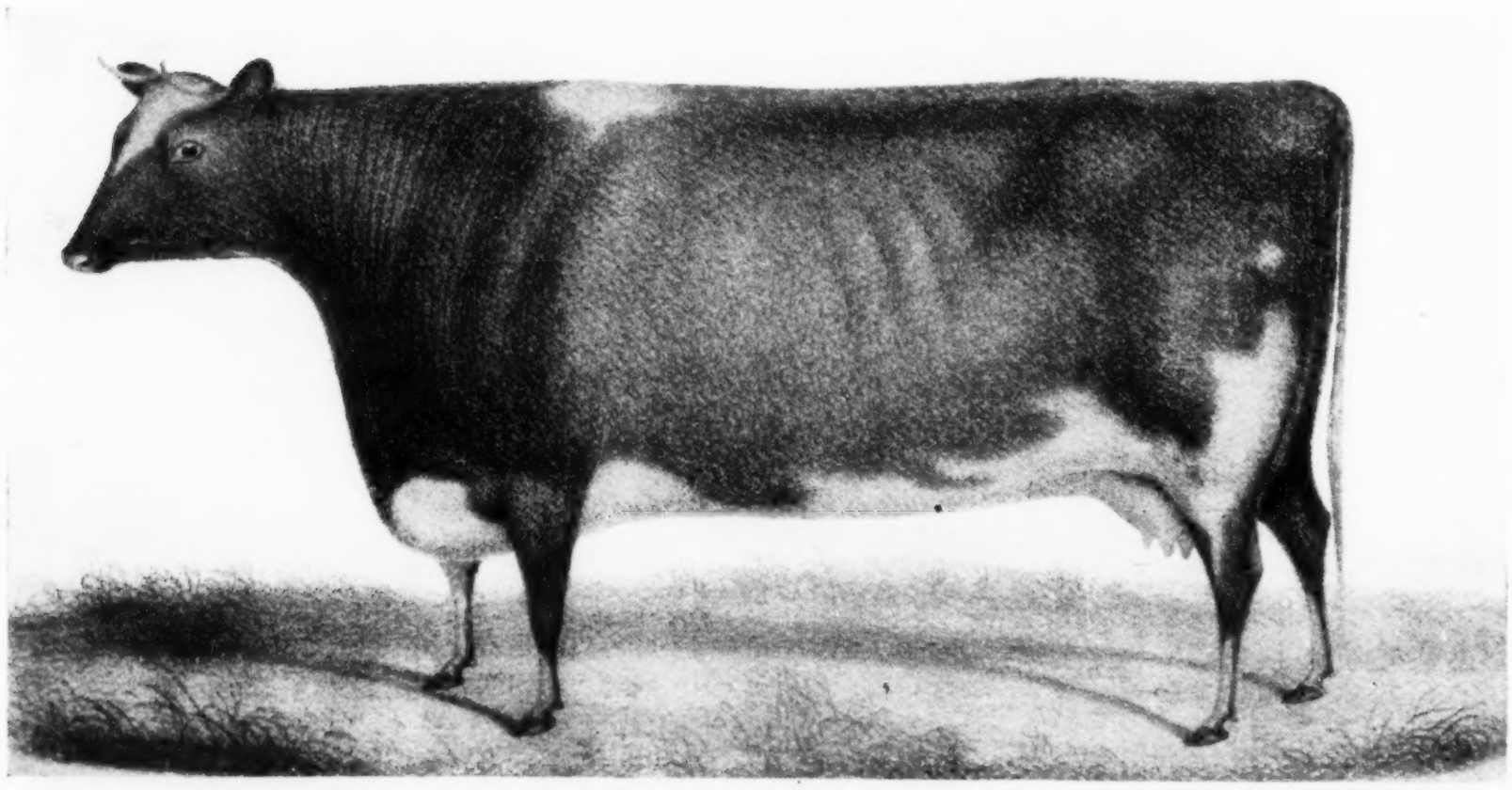
The most important "outcrosses" in the later years were those with the descendants of the Matchem Cow. The latter was not closely related to the Duchesses or even to Favourite ($R = 22$ per cent), but as her blood was introduced into the Duchess line only through her sons, the Cleveland Lads, sired by the Duchess bull, Shorttail, and through her grandson, 2nd Duke of Oxford, with two Duchess top crosses, the result was merely that Bates kept the degree of inbreeding from rising above its previous level by introducing this dash of outside blood.

We must conclude that Bates simply maintained from the beginning to the end of his breeding career a certain average degree of relationship between the animals he mated (about 60 per cent), a degree distinctly higher than that between an ordinary brother and



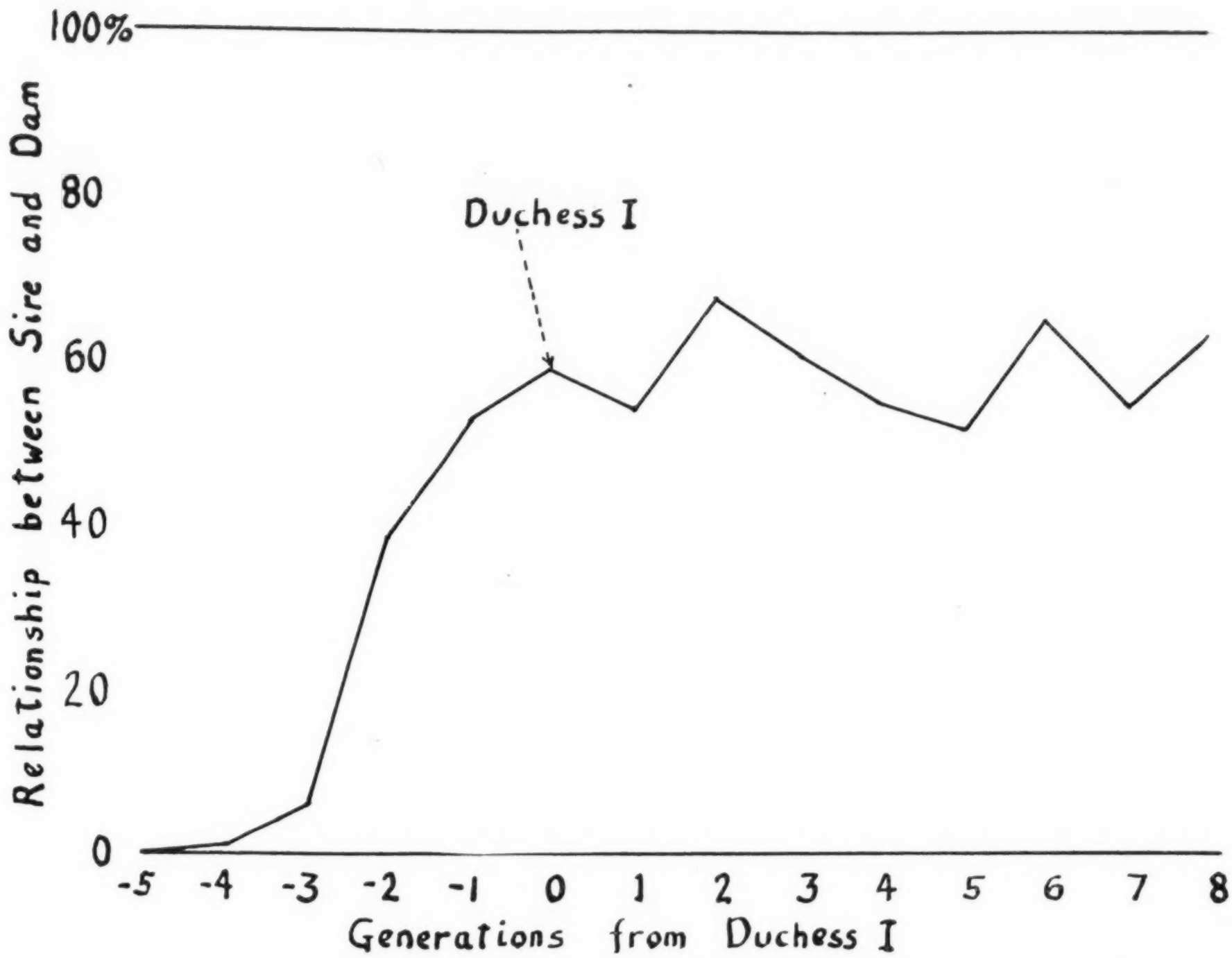
BELVIDERE

FIGURE 19. Bates' greatest success began with the use of the "Princess" bull, Belvidere (1706), which, although lacking in Duchess blood, was closely inbred to the foundation sire, Favourite, and through the latter was as closely related to the Duchess cows as an ordinary full brother.



OLD BROKEN-LEG

FIGURE 20. Daughter of Belvidere and dam of Duke of Northumberland, Old Broken Leg (Duchess 34th) was one of Bates' most famous Duchesses. Her merits as an individual were established by her notable victory over John Booth's cow, Necklace, at the York show in 1842.



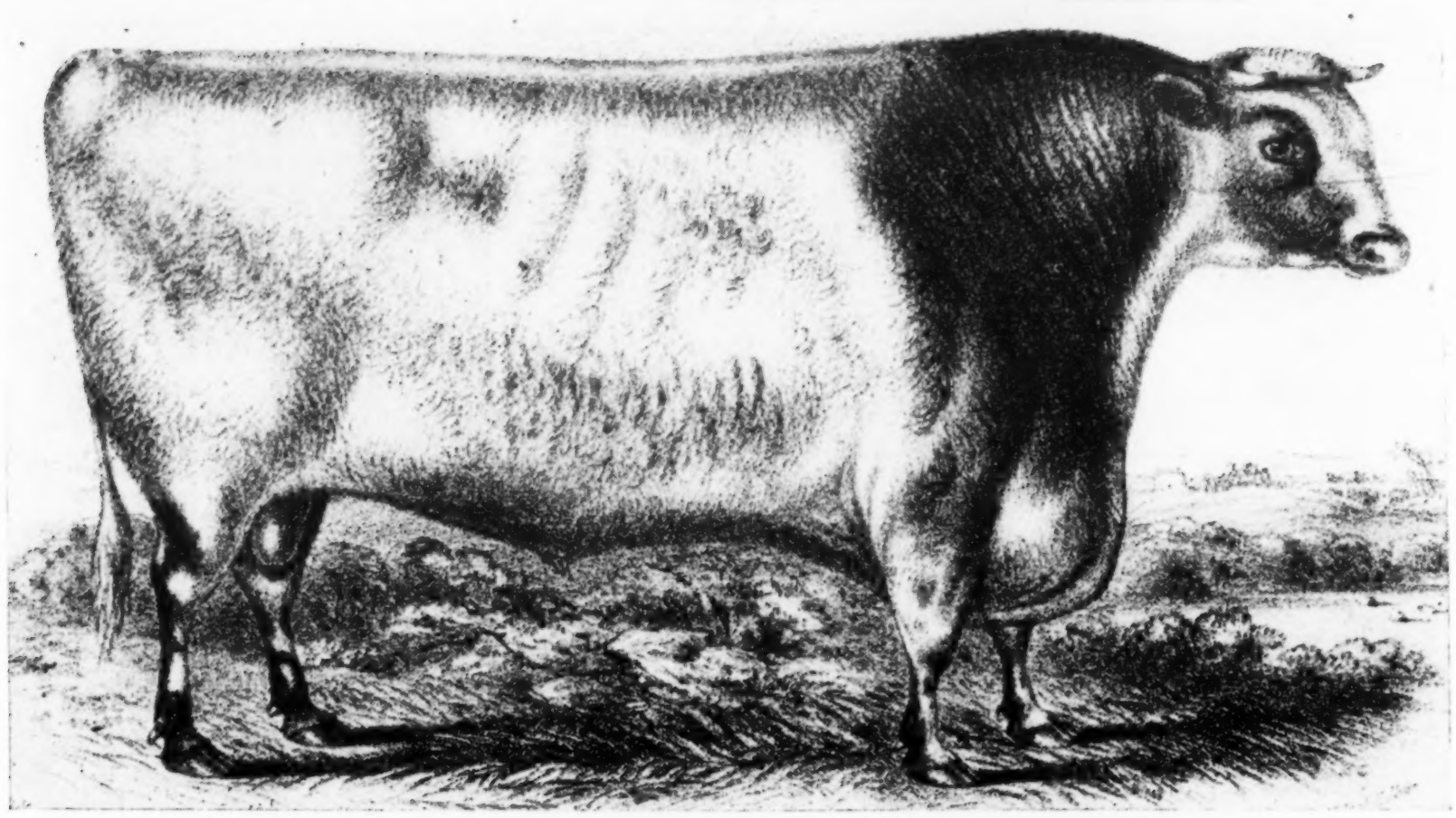
RELATIONSHIP BETWEEN SIRES AND DAMS OF THE DUCHESSES

FIGURE 21. The degrees of relationship between the sires and dams of the eight generations of Duchesses bred by Thomas Bates and six earlier generations in the straight female line. The coefficients of relationship are theoretically equal to the coefficients of correlation with respect to characters which are wholly hereditary and lacking in dominance.

sister. He constantly introduced fresh blood but only to such an extent as to prevent the relationship from rising above this level.

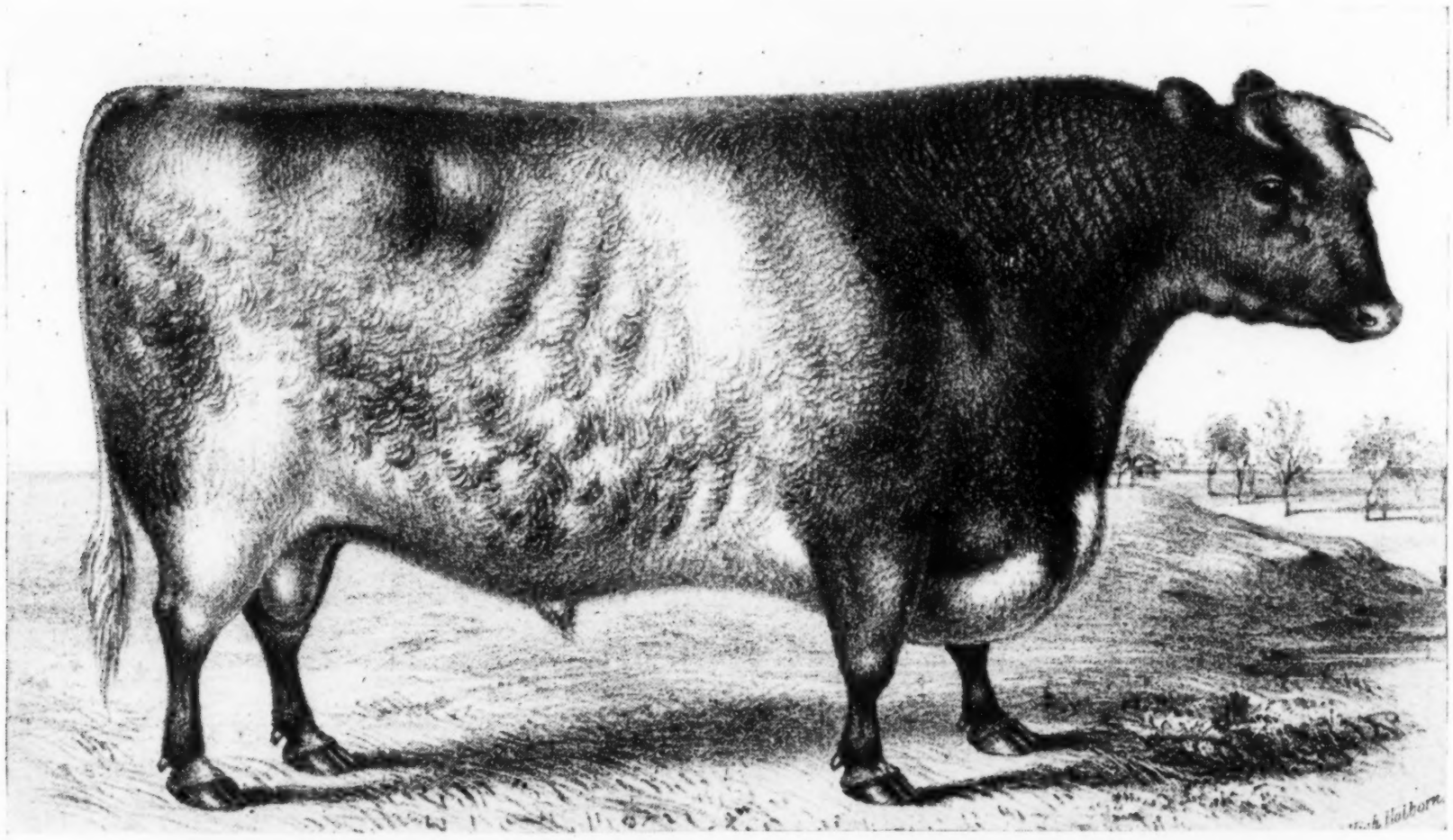
The Degree of Inbreeding Used by Bates

The coefficients of inbreeding of the thirteen generations of Duchesses are shown in the solid line in Figure 24. That of their dams (also, of course, Duchesses, but in a different order) and of their sires are given in dotted and broken lines respectively. The striking feature of this diagram is the similarity of the three lines at a constant level of about 40 per cent beginning with Duchess I. Duchess by Daisy Bull, two generations earlier, is the first Duchess which shows an appreciable amount of inbreeding (20 per cent). Duchess by Favourite in the next generation rises to 32 per cent. Duchess I, bred by Colling and purchased by Bates, rises to 41 per cent. From this point on no generation rises above 47 per cent or falls below 36 per cent. The coefficient for the last generation, 43 per cent, is practically the same as that for Duchess I and for the average of the first two generations which Bates himself bred. This level of inbreeding is approximately equivalent to two generations of straight brother-sister mating, something over four generations of pure breeding within a herd (half brother-sister mating) and six generations of double first-cousin mating. In maintaining it, Bates used bulls, wheth-



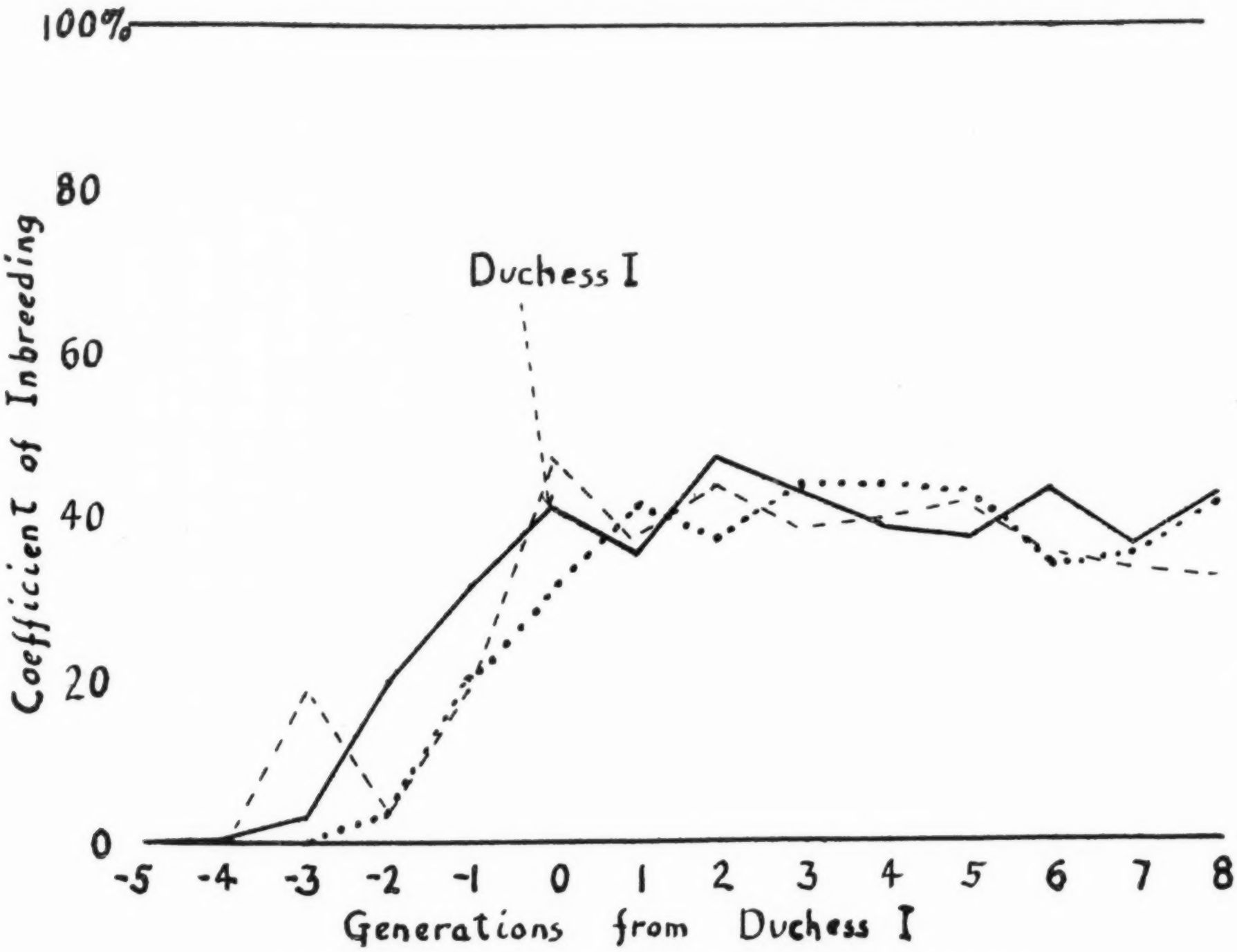
COMET

FIGURE 22. The bull Comet (155), bred by Charles Colling, was one of the most important foundation sires of the Shorthorn breed. He was the sire of Bates' Duchess I. In spite of his close inbreeding, 47.1 per cent, he was a remarkably vigorous animal and considered the best bull of his time. At Charles Colling's dispersion sale he sold for the record price of 1,000 guineas.



NORFOLK

FIGURE 23. Norfolk (2377), bred by James Whitaker, was one of the bulls used by Bates to introduce a dash of fresh blood into his herd. Many of the later day Duchesses descended from him. Like the other bulls used by Bates for this purpose, he was closely related to the Duchesses genetically through his descent in many lines from Favourite. Bates' so-called "outcrosses" merely kept the degree of inbreeding from rising above the level—about 40 per cent—with which he started.



DEGREE OF INBREEDING OF THE DUCHESSES

FIGURE 24. The degrees of inbreeding of the Duchesses (solid line), of their sires (broken line), and dams (dotted line). The original Duchess was purchased by Charles Colling in 1784. Duchess I, five generations later, was purchased from Colling by Bates, who bred eight generations, including sixty-three cows, before his death in 1849. The coefficient of inbreeding measures the approach toward complete homozygosis. The coefficient of 40 per cent maintained by Bates means 40 per cent less heterozygosis than was present in the foundation stock.

er of his own or other breeding, which were inbred to substantially the same extent, 40 per cent, as the cows and related to them as we have seen, about 60 per cent. With regard to factors in which the original Shorthorns were only 50 per cent homozygous, the sires used by Bates and his whole Duchess family were about 70 per cent homozygous from the automatic effect of inbreeding alone.

Relationship to Favourite

Finally it is interesting to see how far Bates maintained relationship to the bull, Favourite, about which as we have seen the Collings centered their efforts at the improvement of Shorthorns. Figure 25 shows the coefficients for the generations of Duchesses in the solid line and those for their dams and sires in dotted and broken lines respectively. Favourite himself appears as a sire of two of the early Duchesses bred by Colling. Bates' Duchess I shows a relationship of 76 per cent. During the following generations bred by Bates, the relationship slowly falls from 69 per cent to about 57 per cent. It is noteworthy that the sires, the majority of which were bred by others, show practically the same coefficients as the Bates-bred cows with which they were bred.

While these lines show a gradual decline, it is a surprising result to find that Bates maintained a strain for forty years after the death of Favourite in which there was a distinctly closer relationship to the latter and hence presumably a closer resemblance than between an ordinary parent and offspring.

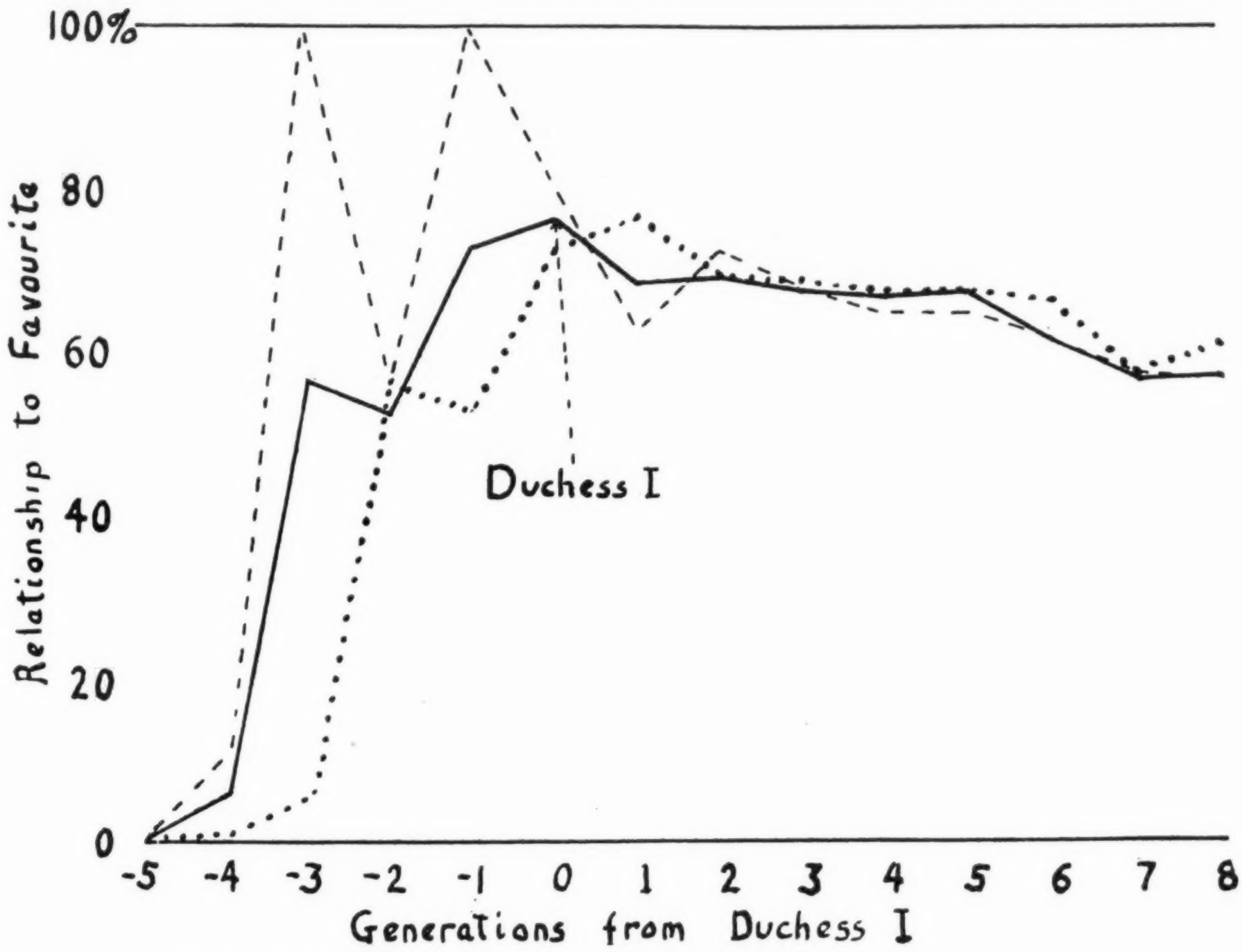
The Significance of Bates' Methods

Bates' own view of inbreeding is contained in a statement handed on by Darwin[1] "to breed in and in from a bad stock was ruin and devastation yet that the practice may be safely followed within certain limits when the parents so related are descended from first-rate animals."

The striking feature of his actual practices as brought out by the above diagrams is their uniformity throughout his whole career. He did not inbreed at the closest possible rate for a few generations and then make violent outcrosses. Neither did he concentrate the blood of one bull for a few generations and then turn to a wholly different line. Whatever the basis in his own mind, he actually pursued a steady policy—maintaining a relationship of nearly 60 per cent between the animals he mated, maintaining a coefficient of inbreeding of something over 40 per cent and maintaining a relationship to the foundation bull, Favourite, falling only slowly from 76 per cent to 57 per cent in eight generations. While our figures do not bring it out, it is well known that he also steadily selected for a certain type. The uniform degree of inbreeding was doubtless a somewhat unconscious result of a balancing between his desire to inbreed to maintain his type and his constant watchfulness over the characteristics of his animals, leading to prompt recognition of the need for a dash of fresh blood.

Through this system he must have been able to maintain without effort a close resemblance to Favourite in numerous features of quality and conformation. The fixation of characters (40 per cent), was not so great, however, but that there was variation and room for constant selection in which he could strengthen those features of the Ketton stock which he favored and get rid of those which he disliked. That he was able to mold the conformation into a distinctive type is the universal testimony of his contemporaries. One of these speaks of seeing his herd driven across country from Ridley Hall to Kirklevington in 1830, being "50 cows and heifers by 2nd Hubback, all as alike as beans and leaving a great impression wherever they passed." The Booths also founded their herds on Ketton stock and their animals would probably show relationship to Favourite of the order of those shown by the Duchesses. Indeed calculation would probably indicate a fairly close relationship between the Bates and Booth herds. Yet Bates and Booth types were recognized as distinctly different. This difference must have been due largely to selection.

Livestock breeders like to compare their work to that of one who molds figures in clay, as suggested above. The successful breeder is often spoken of as molding the conformation of his animals to the ideal type which he has in mind. If clay is to be worked into shape it must have just the right plasticity. Similarly with livestock. If Bates had not maintained close relationship between the animals which he mated, the relatively high degree of inbreeding, and close relationship to one animal (Favourite) his material would probably have been too plastic. The simultaneous variation in all characters would have been more than he could have contended with. If on the other hand he had bred wholly within his herd and between full brother and sister as far as possible, his material would soon not have been plastic enough to mold into shape. Undesirable characters, moreover, would almost certainly have become ineradicably fixed. As it was, a low level of fertility seems to have become fixed and to have doomed the efforts to maintain



RELATIONSHIP OF THE DUCHESS COWS TO FAVORITE

FIGURE 25. The degrees of relationship to the bull Favourite of the Duchesses (solid line), of their sires (broken line), and of their dams (dotted line). For eight generations Bates maintained a closer resemblance to Favourite than between parent and offspring (50 per cent) in a stock not inbred.

a "pure" Duchess strain after Bates' death. On the whole it must be conceded that Bates managed to maintain a happy medium with respect to the plasticity of his stock.

Let us compare a little more closely the methods followed by Bates and those suggested by Mendelian theory. In combining inbreeding and selection there are several methods which may logically be followed depending on the genetic complexity of the characters, the importance of environmental variation and such factors as the extent of the operations and the amount of risk to be undertaken.

The first step in any case should be selection of a vigorous foundation, approaching as closely as possible to the desired type. This was the step taken by the Collings in purchasing the original Duchess, Favourite Cow, the bull Hubback, and so forth.

With such a foundation stock, one might practice the most intensive inbreeding in a large number of distinct lines, knowing that most lines would inevitably deteriorate greatly, but trusting that a few would be found in which desirable qualities would become fixed, and in which the deterioration in any vital respect would be so slight that they could be maintained successfully. By crossing such lines which have withstood this acid test of inbreeding, one might reasonably hope to recover more than the original vigor and retain those characters which had

been fixed. Such a method is especially indicated where the characters are of a kind determined so slightly by heredity that genetic differences can be recognized only on comparing lines which have been kept distinct and free from outside blood. This method, an alternation of intensive inbreeding with selection and crossbreeding of the few successful lines must naturally be done on a large scale and with the undertaking of considerable risk. It is a method adapted rather to experiment stations than to private individuals. It is, however, an important method and has some parallel in the general history of the breeds. Many of the early breeders practiced close inbreeding. Only a few like the Collings were notably successful. The strains developed by these successful breeders were intercrossed to found the present pure breeds.

For the individual breeder, however, theory as well as practice indicate that the most reliable method is the maintenance of a steady level in closeness of breeding coupled with persistent selection toward the desired type, the requisite closeness of breeding depending, naturally, on the heterogeneity of the foundation animals and the breeder's skill as a judge of livestock.

Our analysis indicates that this was the method pursued by Bates. In view of Bates' success we may infer that the degree of inbreeding practiced by him, 40 per cent, represents about the right amount in the hands of an exceptionally able judge of cattle, working with a material as heterogeneous as the original Shorthorns.

Summary

It is shown that in establishing the famous Duchess family of Shorthorns, Thomas Bates started with Collingbred stock already about 40 per cent inbred (i. e., which was 40 per cent less heterozygous than the original Shorthorns). During the eight generations which he bred himself, through a period of about forty years, he maintained substantially the same level of inbreeding by constantly introducing just the right amount of fresh blood to keep the percentage from rising above 40 per cent. He used bulls, whether of his own or other breeding, which averaged about 40 per cent inbred. The relationship between the Duchess cows and the bulls with which they were mated, whether bred by himself or others, was kept at such point that a correlation of about + .60 would be present in purely hereditary nondominant characters, throughout the eight generations. Finally during these eight generations a high correlation, falling gradually from .76 to .57 was maintained with Colling's bull, Favourite.

It is suggested that these levels of inbreeding and relationship yielded the proper balance between the extreme plasticity of the original heterogeneous Shorthorn stock and the more complete fixation of characters which would have resulted from closer inbreeding, to enable Bates, with his great skill as a judge of cattle to maintain a high degree of vigor and to mold a new type according to his ideals on the basis of the type represented by Charles Colling's bull, Favourite.

Literature Cited

[1] Darwin, Charles. Animals and Plants Under Domestication, 1868.

[2] Wright, S. Mendelian Analysis of the Pure Breeds of Livestock. I. The Measurement of Inbreeding and Relationship. *Journal of Heredity* 14:339-348. 1923.

TABLE I—*The parentage of the bulls used by Bates in developing his Duchess family.*

Bull	Sire	Dam
Favourite (252)	Bolingbroke (86)	Phoenix
Daisy Bull (186)	Favourite (252)	By Punch[1] (531) out of daughter of Hubback (319)
Comet (156)	Favourite (252)	Young Phoenix by Favourite out of Phoenix (his dam)
Ketton (709)	Favourite (252)	Duchess by Daisy Bull
Ketton II (710)	Ketton (709)	By son of Favourite out of daughter of J. Brown's bull[2] (97)
Ketton III (349)	Ketton II (710)	Duchess 3
Marske (418)	Favourite (252)	By Favourite out of daughter of Favourite[3]
Cleveland (146)	Ketton III (349)	Duchess 1
Young Marske (419)	Marske (418)	Duchess 4
The Earl (646)	Duke[4] (226)	Duchess 3
2nd Earl (1511)	The Earl (646)	Duchess 3
3rd Earl (1514)	The Earl (646)	Duchess 8
2nd Hubback (1423)	The Earl (646)	Red Rose I (see Figure 16)
		Angelina (see Figure 15)
Belvidere (1706)	Waterloo (2816)	Matilda (see Figure 18)
Gambier (2046)	Bertram (1716)	Nonpareil (see Figure 17)
Norfolk (2377)	2nd Hubback (1423)	Duchess 32
Shorttail (2621)	Belvidere (1706)	By 2nd Hubback out of daughter of 2nd Hubback[5]
Holkar (4041)	Belvidere (1706)	Duchess 34
Duke of Northumberland (1940)	Belvidere (1706)	Duchess 34
2nd Duke of Northumberland (3646)	Belvidere (1706)	Duchess 34
4th Duke of Northumberland (3649)	Shorttail (2621)	Matchem Cow[6]
Cleveland Lad (3407)	Shorttail (2621)	Matchem Cow[6]
2nd Cleveland Lad (3408)	Shorttail (2621)	By Cleveland Lad out of daughter of Belvidere[7]
Lord Barrington (9308)	2nd Duke of Northumberland (3646)	Oxford 2nd (full sister of the Cleveland Lads)
2nd Duke of Oxford (9046)	Duke of Northumberland (1940)	

[1] Punch was by Broken Horn (95) out of his own daughter. Broken Horn in turn was both son and grandson of Hubback (319), who thus appears four times in the ancestry of Punch within four generations.

[2] J. Brown's Bull (97) was a great grandson of the Studley Bull (626).

[3] The more remote top sires of Marske were Punch, Hubback, Snowden's Bull (612) and Masterman's Bull (422). The last three appear in the pedigree of Favourite.

[4] Duke (226) was by Comet out of Duchess by Favourite and was hence a full brother of Duchess I.

[5] The great great granddam of Holkar (female line) was by a son of Hubback.

[6] The Matchem Cow introduces more outside blood than any other animal in the table. Her sire, Matchem (2281) had four top crosses of bulls without any blood of Favourite or closely related animals as far as known certainly. Favourite appears as the fifth top sire and again as the eighth. Bolingbroke was the seventh, Foljambe the ninth and Hubback the tenth. Only the maternal grandsire of the Matchem Cow, Young Wynyard (2859), had much Favourite blood. He appears in the pedigree of Belvidere as both maternal and paternal grandsire.

[7] The fourth top sire was a grandson of Favourite and had other Favourite blood; the fifth and sixth top sires also had much Favourite blood while the seventh was Favourite himself.

TABLE II—*The coefficients of inbreeding of the Bates Duchesses and of their sires and dams, the degree of relationship between the latter and the degrees of relationship to the foundation bull, Favourite.*

Individual	Born	Generation	Parents: Sire	Parents: Dam	Inbreeding: Ind.	Inbreeding: Sire	Inbreeding: Dam	Relationship: Sire and Dam	Relationship: To Favourite: Ind.	Relationship: To Favourite: Sire	Relationship: To Favourite: Dam
A (Duchess)	.....	1	J. Brown's Bull (97)	....	0	0	0	0	0.3	0.5	.....
B (Unnamed)	.....	2	Hubback (319)	A	0.2	0	0	0.4	6.0	11.8	0.3
C (Unnamed)	.....	3	Favourite (252)	B	3.3	19.2	0.2	6.0	56.7	100.0	6.0
D (Duchess)	1800	4	Daisy Bull (186)	C	19.9	3.4	3.3	38.6	52.6	56.8	56.7
E (Duchess)	.....	5	Favourite (252)	D	31.5	19.2	19.9	52.6	72.7	100.0	52.6
Duchess 1	1808	6	Comet (155)	E	40.8	47.1	31.5	58.7	76.3	80.5	72.7
" 2	1812	7	Ketton (709)	1*	43.2	31.5	40.8	63.5	72.7	72.7	76.3
" 3	1815	7	Ketton (709)	1	43.2	31.5	40.8	63.5	72.7	72.7	76.3
" 4	1816	7	Ketton 2nd (710)	1	27.9	11.8	40.8	44.5	64.5	52.4	76.3
" 5	1817	7	Ketton 2nd (710)	1	27.9	11.8	40.8	44.5	64.5	52.4	76.3
" 6	1819	8	Ketton 3rd (349)	4	43.5	33.3	27.9	66.6	60.2	61.6	64.5
" 7	1820	8	Marske (418)	3	42.5	45.7	43.2	58.8	76.8	79.9	72.7
" 8	1820	8	Marske (418)	2	42.5	45.7	43.2	58.8	76.8	79.9	72.7
" 9	1821	8	Marske (418)	2	42.5	45.7	43.2	58.8	76.8	79.9	72.7
" 10	1821	8	Cleveland (146)	4	46.3	42.4	27.9	68.7	63.6	67.8	64.5
" 11	1822	8	Young Marske (419)	5	40.6	35.6	27.9	61.6	66.4	72.7	64.5
" 12	1822	8	The Earl (646)	4	43.3	49.2	27.9	62.7	67.6	72.6	64.5
" 13	1823	9	The Earl (646)	9	47.9	49.2	42.5	65.6	74.2	72.6	76.8
" 14	1823	9	The Earl (646)	6	44.4	49.2	43.5	60.7	66.9	72.6	60.2
" 15	1824	9	The Earl (646)	8	47.9	49.2	42.5	65.6	74.2	72.6	76.8
" 16	1824	8	The Earl (646)	3	60.4	49.2	43.2	82.6	69.4	72.6	72.7
" 17	1825	9	3rd Earl (1514)	11	44.0	47.9	40.6	61.0	70.4	74.2	66.4
" 18	1825	9	2nd Hubback (1423)	6	33.2	27.0	43.5	49.1	62.9	64.9	60.2
" 19	1825	9	2nd Hubback (1423)	12	41.8	27.0	43.3	61.9	64.7	64.9	67.6
" 20	1825	9	2nd Earl (1511)	8	48.5	60.4	42.5	64.1	73.7	69.4	76.8
" 21	1825	8	2nd Earl (1511)	3	66.0	60.4	43.2	87.1	67.9	69.4	72.7
" 22	1826	9	2nd Hubback (1423)	9	37.8	27.0	42.5	56.2	70.2	64.9	76.8
" 23	1826	9	2nd Earl (1511)	11	43.9	60.4	40.6	58.4	69.5	69.4	66.4
" 24	1826	9	2nd Hubback (1423)	6	33.2	27.0	43.5	49.1	62.9	64.9	60.2
" 25	1826	9	2nd Hubback (1423)	8	37.8	27.0	42.5	56.2	70.2	64.9	76.8
" 26	1826	8	2nd Hubback (1423)	3	43.5	27.0	43.2	64.5	66.8	64.9	72.7
" 27	1827	9	2nd Hubback (1423)	16	47.2	27.0	60.4	66.0	66.4	64.9	69.4
" 28	1827	9	2nd Hubback (1423)	6	33.2	27.0	43.5	49.1	62.9	64.9	60.2
" 29	1829	10	2nd Hubback (1423)	20	42.5	27.0	48.5	61.9	68.2	64.9	73.7
" 30	1830	10	2nd Hubback (1423)	20	42.5	27.0	48.5	61.9	68.2	64.9	73.7
" 31	1830	9	2nd Hubback (1423)	26	53.5	27.0	43.5	79.3	61.8	64.9	66.8
" 32	1831	10	2nd Hubback (1423)	19	52.6	27.0	41.8	78.5	60.8	64.9	64.7

TABLE II—*Continued*

Individual		Born	Generation	Parents: Sire	Parents: Dam	Inbreeding: Ind.	Inbreeding: Sire	Inbreeding: Dam	Relationship: Sire and Dam	Relationship: To Favourite Ind.	Relationship: To Favourite Sire	Relationship: To Favourite Dam
Duchess	33	1832	10	Belvidere (1706)	19	32.8	52.3	41.8	44.6	68.1	64.8	64.7
"	34	1832	11	Belvidere (1706)	29	34.5	52.3	42.5	46.8	69.6	64.8	68.2
"	35	1833	10	Gambier (2046)	19	31.9	32.3	41.8	46.5	66.4	65.5	64.7
"	36	1834	10	Belvidere (1706)	19	32.8	52.3	41.8	44.6	68.1	64.8	64.7
"	37	1834	11	Belvidere (1706)	30	34.5	52.3	42.5	46.8	69.6	64.8	68.2
"	38	1835	11	Norfolk (2377)	33	31.2	19.5	32.8	49.5	60.7	55.4	68.1
"	39	1835	11	Belvidere (1706)	30	34.5	52.3	42.5	46.8	69.6	64.8	68.2
"	40	1835	10	Belvidere (1706)	19	32.8	52.3	41.8	44.6	68.1	64.8	64.7
"	41	1835	11	Belvidere (1706)	32	32.1	52.3	52.6	42.2	67.5	64.8	60.8
"	42	1837	11	Belvidere (1706)	30	34.5	52.3	42.5	46.8	69.6	64.8	68.2
"	43	1837	12	Belvidere (1706)	34	55.3	52.3	34.5	77.3	64.5	64.8	69.6
"	44	1838	12	Shorttail (2621)	37	48.5	32.1	34.5	72.8	65.0	67.5	69.6
"	45	1838	11	Shorttail (2621)	30	42.9	32.1	42.5	62.5	66.5	67.5	68.2
"	46	1838	12	Shorttail (2621)	34	48.5	32.1	34.5	72.8	65.0	67.5	69.6
"	47	1839	12	Shorttail (2621)	37	48.5	32.1	34.5	72.8	65.0	67.5	69.6
"	48	1839	11	Shorttail (2621)	30	42.9	32.1	42.5	62.5	66.5	67.5	68.2
"	49	1839	11	Shorttail (2621)	30	42.9	32.1	42.5	62.5	66.5	67.5	68.2
"	50	1839	12	Duke of Northumberland (1940)	38	40.1	55.3	31.2	56.2	63.3	64.5	60.7
"	51	1840	12	Cleveland Lad (3407)	41	32.9	11.6	32.1	54.2	55.3	47.4	67.5
"	52	1841	12	Holkar (4041)	38	36.0	24.0	31.2	56.4	58.8	60.7	60.7
"	53	1842	12	Duke of Northumberland (1940)	41	51.3	55.3	32.1	71.7	64.2	64.5	67.5
"	54	1844	12	2nd Cleveland Lad (3408)	49	32.6	11.6	42.9	51.6	56.3	47.4	66.5
"	55	1844	12	4th Duke of Northumberland (3649)	38	40.7	48.5	31.2	58.3	62.7	64.9	60.7
"	56	1844	13	2nd Duke of Northumberland (3646)	51	41.7	55.3	32.9	58.1	60.5	64.5	55.3
"	57	1845	13	2nd Cleveland Lad (3408)	50	28.8	11.6	40.1	46.1	59.0	47.4	63.3
"	58	1846	13	Lord Barrington (9308)	54	34.5	36.8	32.6	51.3	57.2	58.1	56.3
"	59	1847	14	2nd Duke of Oxford (9046)	56	42.8	32.1	41.7	62.6	57.4	56.7	60.5
"	60	1848	13	2nd Duke of Oxford (9046)	54	36.3	32.1	32.6	54.9	55.7	56.7	56.3
"	61	1848	13	2nd Duke of Oxford (9046)	51	37.8	32.1	32.9	57.1	54.9	56.7	55.3
"	62	1848	14	2nd Duke of Oxford (9046)	56	42.8	32.1	41.7	62.6	57.4	56.7	60.5
"	63	1848	13	2nd Duke of Oxford (9046)	54	36.3	32.1	32.6	54.9	55.7	56.7	56.3
"	64	1849	13	2nd Duke of Oxford (9046)	55	39.1	32.1	40.7	57.4	57.6	56.7	62.7

TABLE III—*A summary by generations (female line) of the coefficients of inbreeding and relationship for the 64 Duchesses, including Duchess I, bred by Charles Colling and purchased by Bates and the 8 generations bred by Bates.*

Generation from Duchess I	No. of Cows	Inbreeding			Relationship			
		Individual	Sire	Dam	Sire and Dam	To Favourite Individual	To Favourite Sire	To Favourite Dam
0 (= Duchess I)	1	40.8	47.1	31.5	58.7	76.3	80.5	72.7
1 (Bates)	4	43.5	21.6	40.8	54.0	68.6	62.5	76.3
2 "	10	47.1	43.4	37.1	67.0	69.2	72.1	69.4
3 "	14	42.4	38.0	43.9	60.2	67.9	67.8	68.7
4 "	7	38.3	38.6	43.7	54.7	66.8	64.9	67.3
5 "	9	36.7	41.9	42.5	51.8	67.3	64.7	67.4
6 "	10	43.4	35.5	33.9	64.4	62.0	61.7	66.2
7 "	7	36.4	33.2	34.9	54.3	56.7	56.7	57.9
8 "	2	42.8	32.1	41.7	62.6	57.4	56.7	60.5
Total	64	40.9	37.5	39.6	59.2	65.6	65.1	67.2

Corn and Corn Growing

CORN AND CORN GROWING. H. A. WALLACE and E. N. PRESSMAN. Pp. 253. Price, $2.25. Wallace Publishing Co., Des Moines, Iowa. 1923.

In the preparation of this book the authors had in mind college instructors, practical corn breeders and farmers. The needs of the two latter classes have been met fairly well, but it is difficult to understand how the book can serve any useful purpose for teachers, lacking as it does even a brief bibliography. The treatment of the history, origin and botanical classification is conventional—with the exception that the origin of the dent type of grain is ascribed to the hybridization of flint and gourd seed forms.

The several methods of breeding have been summarized sanely and the conclusion reached that the method of combining inbred strains is the only remaining possibility of increasing yield.

The space devoted to heredity is largely taken up with a list of heritable characters and their symbols furnished by Professor R. A. Emerson and geneticists will welcome the appearance of this material in print. The discussion of the subject of heredity, however, is too elementary to interest the teacher and too technical to enlighten the grower.

An admirable effort obviously has been made to avoid dogmatic statements on debatable points, but there have been some failures as evidenced by the conclusion that "each row of corn corresponds to a spike and the entire ear is a combination of a number of spikes which have grown together," or that "Each ear shank contains as many nodes as the stalk bears above the ear."

The discussion of cultural practice, harvesting and testing of seed corn, marketing, cost of production and judging, is probably the best to be found in any one publication and should prove of value to corn growers.

J. H. K.

ASIATIC BREEDS OF SHEEP

Considered From the Standpoint of Tail Formation

C. C. YOUNG
Denver, Colorado

WHEN we consider the Asiatic breeds of sheep from the standpoint of tail development, it is possible to divide them into five groups—longtails, shorttails, broadtails, fatrumps, and fattails. The most important to us are, of course, the longtail sheep, of which there are very few in Asia, but when we do find them there they are not unlike our longtail sheep in this country, possessing from sixteen to twenty-four vertebrae and more in their tails.

The shorttail sheep, of which we have none in this country, have generally from three to five vertebrae in their tails.

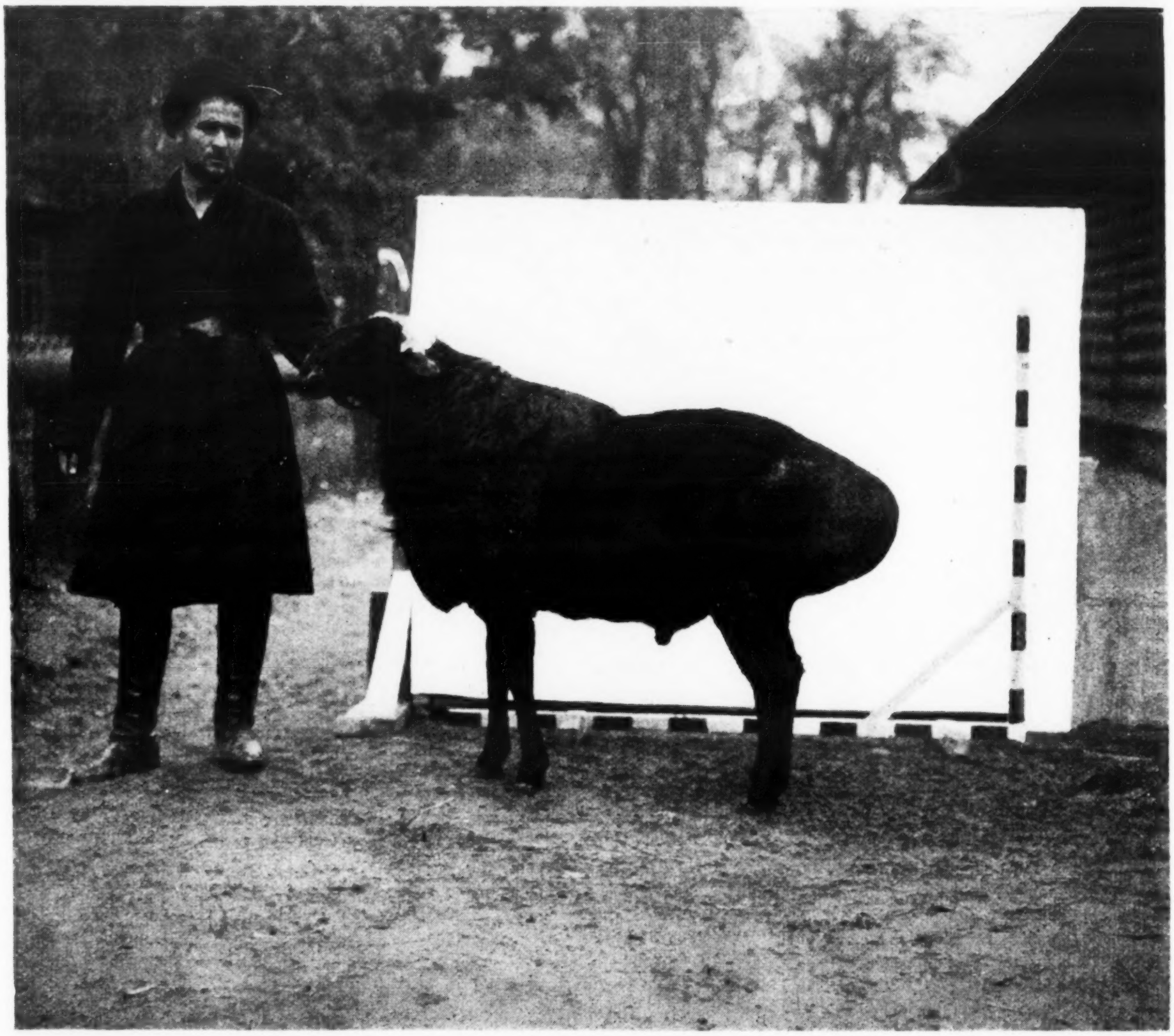
Next in importance is the fatrump (*Ovis Steatopyga*) which often has no tail at all, but has two huge fat pillows that fit on the buttocks, and on cutting into these are often found embedded remnants of a tail consisting of two or three small vertebrae. Not infrequently there is a tail from two to three inches long and the thickness of a man's finger which protrudes from about the center of the fat lobules at their juncture, and which is generally covered with a very course hair varying in color. Most of the fatrump breeds are red in color, and this the reader must remember as I will speak of this particular pigment again.

Three different fatrump breeds have been brought into the United States: the Achuri from Persia by Bailey, the Khirgiz from West Turkestan by Hanson and the Kalmick from Central Asia by myself.

Where I crossed fatrumps to longtails I was able to produce broadtails (*Ovis Platyura*) of which there are a great many varieties. Indeed it is not an unusual thing to find, in this country, typical broadtail sheep that result from a cross of our native longtail sheep on the Achuri, commonly known in this country under the name of "Persian." Professor Hanson, of South Dakota, was able to produce typical broadtail sheep by crossing Khirgiz fatrumps on certain domestic longtail sheep. The Tartar, Mongol, Chulmi, Tshuiskoe, Kalmick, Buriat, Achuri, Dedick, Tshuntuk and many other Asiatic sheep are of the fatrump group.

There are a great many broadtail breeds in Central Asia and Asia Minor and in Southeast Europe, but none of them produce tight curls except the Karakuls. The Malitch of the Crimea, the Karachaev and Osetin of the Caucasus often produce very lustrous but open curls, except where they have been bred to Karakuls. The only two broadtail breeds that were ever imported to the United States, namely the Karakul and the Karachaev were brought here by myself. The latter often possess more than two horns. In the broadtail breeds we have generally the same number of vertebrae in the tail, as is the case with the longtails, but on each side of the upper three-fourths of it we find a broad triangular flap consisting mostly of adipose tissue, which gives it the appearance of a very broad tail, hence the name *Ovis platyura*.

The fattail breeds are not numerous and we have none of them in the United States. They must not be confused with the broadtail or fatrump breeds which are sometimes called, in this country, fattails. The fattail is a longtail which has up to forty-two vertebrae in its tail, which often drags on the ground. Throughout its entire length the tail is about as



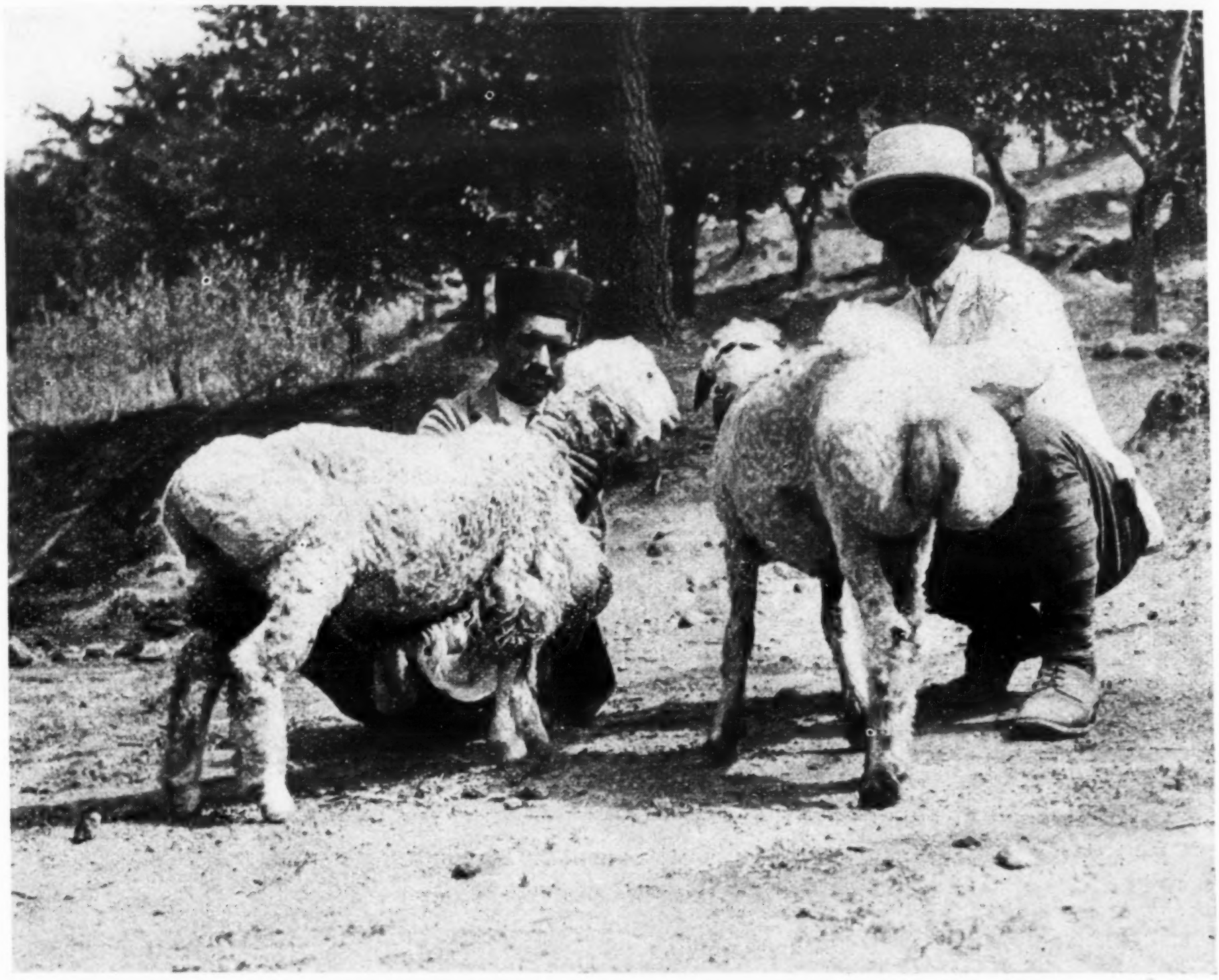
BLACK FATRUMP RAM

FIGURE 26. This ram is typical of the Tshuiskoe breed of Bokhara. Most fatrump sheep are red, and it is from these red breeds that much of the deterioration in the quality of the fur-bearing Karakuls has come.

broad again as the average longtail, often broader. I am under the impression that the fattails resulted from a cross of the fatrumps on the longtails, as on two occasions I have observed among Karakuls typical fattail sheep. Suffice it to say here that the typical fattailed breed in Russia is the Voloshskaja, but there are several others.

Breeds of Fur-Sheep

There are no tight curled fur-bearing sheep among the fatrumps, fattails or shorttails, but we do find them among the broadtails and the longtails. With the exception of the Karakul and the practically extinct Danadar breeds no other sheep known has ever produced the much wanted pipe-like and pin-head tight curls. Such breeds as the Karachaev, the Osetin and other breeds of Asia Minor, and the Malitch of the Crimea (which often gives us a gray skin, "the Krimmer,") have given us beautiful, black, lustrous skins, but with open curls, as previously stated, and the same thing applies to such longtail breeds as the Tchushka of Bessarabia, the Reshetiliev and Sokoliev of Poltava. If here and there tight curled skins were produced by the Malitch breed of the Crimea, it



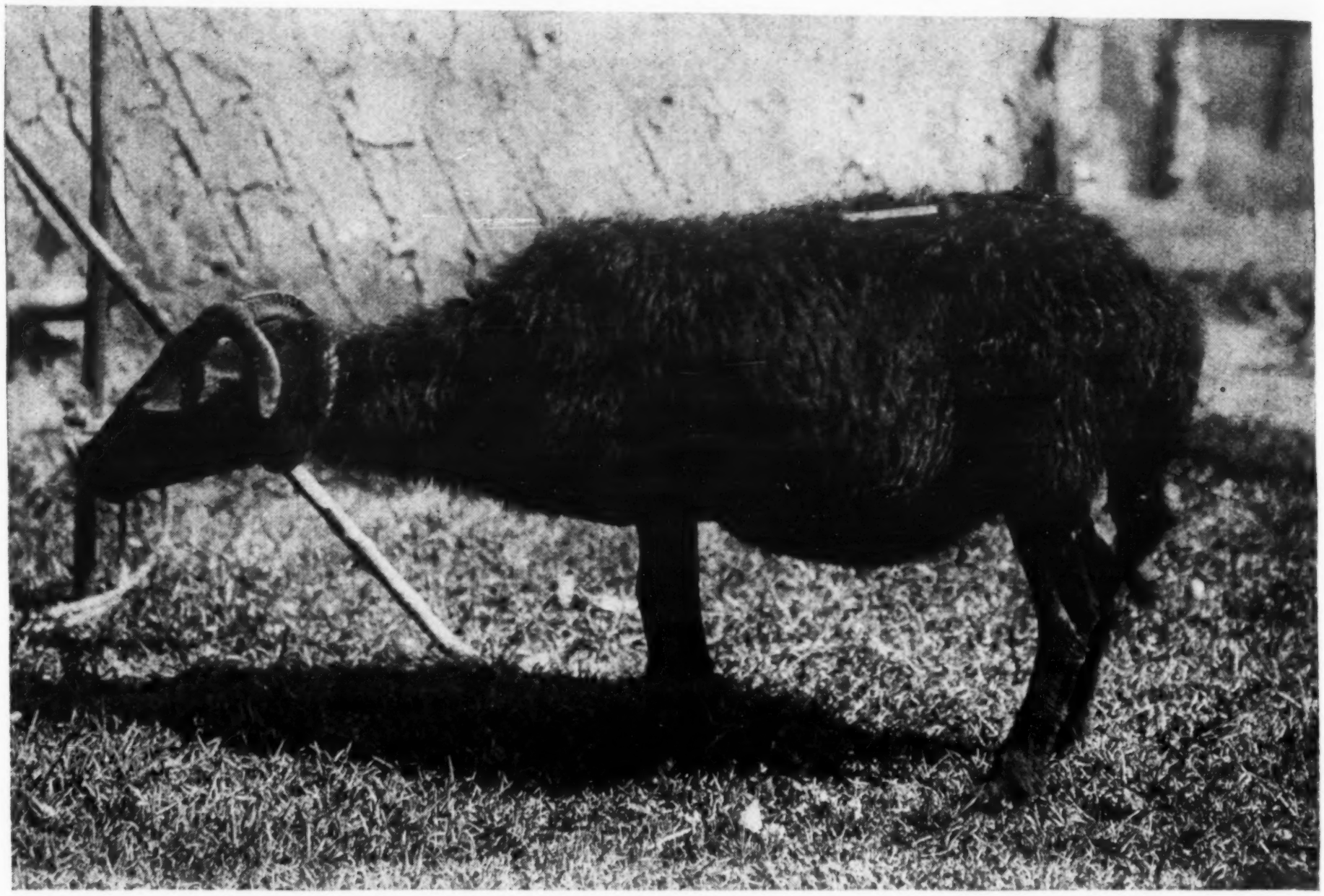
FATRUMP AFGHAN SHEEP

FIGURE 27. These sheep were photographed just after shearing, by an English engineer, A. C. Jewett, who entered Afghanistan in 1912, some months before the author.

was entirely due to Karakul admixture and the same thing must be said of the breeds above mentioned.

The Karakul owes its fur bearing qualities to the Danadar. Both breeds are indigenous to West Turkestan, Northern Persia and Afghanistan. The black Danadar, the original fur sheep of Central Asia, has become practically extinct in the past ninety years and outside of the small flock discovered by the Dragoman Petroff, of New Bokhara, and myself at Kedjumek, Bokhara, I cannot say that I have ever seen another herd, although it is possible to view occasionally a Karakul with the typical characteristics of the Danadar, the result of atavism.

I have the best of reasons to believe that had I been enabled to explore the territory on both the Bokhara and Afghan sides of the Upper Piandge I probably would have found a few more Danadars, but an expedition through that country is a stupendous task. In fact it was impossible for a foreigner to penetrate that country before the war on account of the fanatical, hostile natives and the dangerous wild animals, and moreover the laws of Russia prohibited foreigners from entering that country. There is little doubt in my mind that the black Gadir of Afghanistan is in reality the black Danadar, who has lost all his fur qualities on account of fine wool admixture of the white fine-wool Afghan sheep. The Look Nakbo of Thibet is another close relative of the Danadar and the same applies to the Osetin and

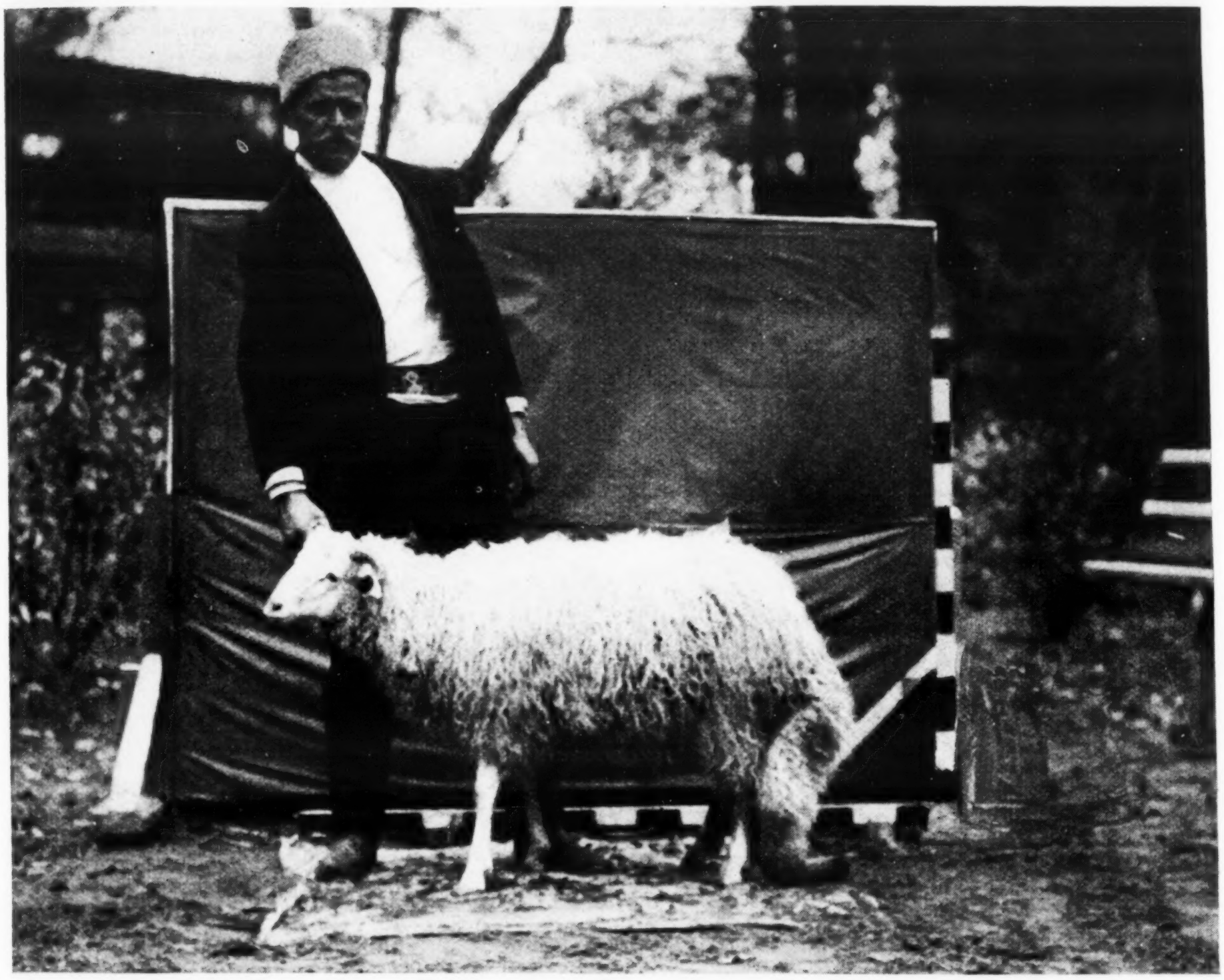


KARACHAEV EWE

FIGURE 28. This is one of the typical broadtail breeds found in North Caucausus and Asia Minor. They frequently have more than two horns. Many broadtail sheep are found in Central Asia, Asia Minor, and Southeast Europe. With the exception of the Karakuls, none of them produce skins having tight surls.

RUSSIAN SHORTTAILED AND LONGTAILED SHEEP

FIGURE 29. On the left is a shorttailed ewe of the breed called Korotkochoostja by the Russians. On the right is a longtailed Sokoliev ewe. All the domestic breeds of sheep in this country are long tailed, but this type has only a very unimportant place among the Asiatic breeds. These sheep were photographed in the province of Poltava, European Russia.



A FATTAILED RAM

FIGURE 30. The tail of this six-months-old Voloshskaja ram is already of fair size. At maturity it will wight twenty pounds or more, as will have to be supported to keep it from wearing itself out against the ground. Sheep of this type are not common in Asiatic Russia.

Karachaev of the Caucasus, the Malitch of the Crimea, the Tchushka of Bessarabia, the Reshetiliev and Sokoliev of the Poltava. The Zigai may also be included.

The original black Danadar was a small sheep with a striking resemblance to the hairy Navajo before that breed was ruined by fine wool admixture. It had thin legs, a small head with straight nose line, short erect ears, a long tail, and coarse lustrous black wool that does not become gray at maturity. This is in contrast with the case of our black Cotswolds, which turn gray when about twelve months old, and with that of the Karakuls free from fine wool admixture.

It was my great fortune to view several Danadar skins at Kedjumek. The Danadar lambs, at birth, possessed wonderful velvety lustrous skins with very small entirely closed curls, in size from that of a black pin head to that of a pea. These curls gradually open up, making it necessary to kill the lambs within a few days after birth. Otherwise the skins lose their beauty and value.

I have seen several Karakul lambs in my flock with the unmistakable pea-like curl of the Danadar. It is possible that in time we might resurrect the extinct Danadar sheep, but it would be an expensive undertaking and it is a great question whether the furrier would pay more for their skins than for the Karakul skins with tight pipe-

THE LAST OF THE DANADARS

FIGURE 31. These sheep are as pure Danadars as have been discovered in recent years, and they are considerably contaminated with fine-wool blood. The Danadar was the original fur sheep of Central Asia, but the pure breed became extinct nearly eighty years ago. Photograph by the Dragoman Petroff, Russian Embassy of New Bokhara.

like curls, known in this country under the trade name of Persian Lamb Fur.

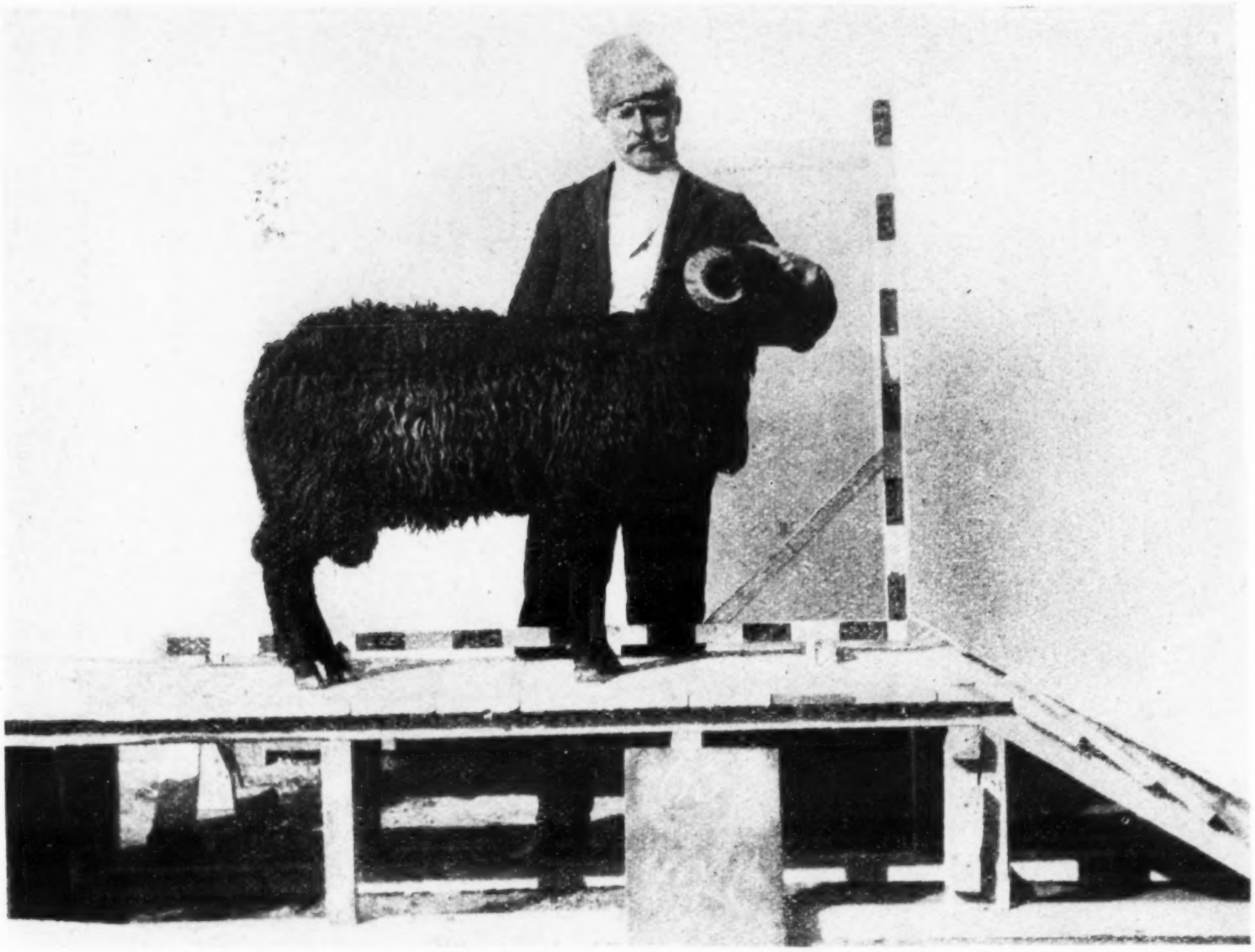
Many of the Danadar sheep that were in those sections of Bokhara lying close to the border of Afghanistan, the home of the white finewool Afghan sheep, became in time gray. Mixture of the Danadars with the fatrump breeds resulted in the development of various peculiar broad tailed breeds which we find today in Central Asia.

Those black Danadars that received but a slight admixture of the fatrump, developed a tail resembling that of half blood to three-quarter blood Karakuls in this country.

No Pure Breeds in Central Asia

The grade Danadar just discussed is the sheep which Dr. Sinitzin found some forty years ago near the Lake of Kara Kul where many Arabs were engaged in sheep raising, and those of their sheep that produced lamb skins of greater value were called "Arabi."

In studying Sinitzin's description of the Arabi, one encounters the same characteristics as are found in the black Danadar, except that the Arabi turn gray at maturity which is not the case with the black Danadar. Sinitzin even speaks of the Arabi as being practically a longtailed sheep. It is easy to understand why Sinitzin saw more of the so-called Arabi than anyone who visited Bokhara twenty to twenty-five years later, since the natives have for years made it a practice to kill the lambs with the most valuable skins. Some investigators realized that



A RESHETILIEV RAM

FIGURE 32. This breed is a close relative of the extinct Danadar. Like the Danadar they have long tails.

it was a difficult matter to speak of any distinct *breeds* of sheep in Central Asia, as we use the word in this country, since the flocks of the natives consist of a mixture of all imaginable kinds of hybrids. The writer is not alone in speaking of the Karakul as being a mongrel sheep. Karpoff, of the Russian Department of Agriculture, is making that quite clear in his bulletin, and one needs but look at a flock of Karakuls to satisfy himself that he is looking at anything but pure bred animals. Only where the closest inbreeding has been practiced is there a semblance of uniformity of type and unfortunately that is accomplished at the expense of the tightness of the curls, upon which the real value of Karakul lamb skins depends, as close inbreeding tends to make the wool finer.

I might explain here that the word "Karakul" covers a multitude of sins in Central Asia and only about one out of a hundred of the so-called Karakuls has enough of the Danadar strain in it to produce the tight curls so much desired.

When it comes to the large Arabi which Sinitzin describes, he could not possibly have meant anything other than the large Karakul, also known as Doozbai. What is more natural than to expect a hybrid, resulting from a cross of the small Danadar upon a fatrump, to possess the characteristics of the fatrump? The typical fatrump possesses a large body, in fact is the largest sheep in the world, with a large generally hornless head, a convex nose line, long drooping ears, thick legs, coarse brittle hairy fleece, generally red. Sinitzin's large Arabi possesses

BROADTAILED SHEEP OF THE CRIMEA

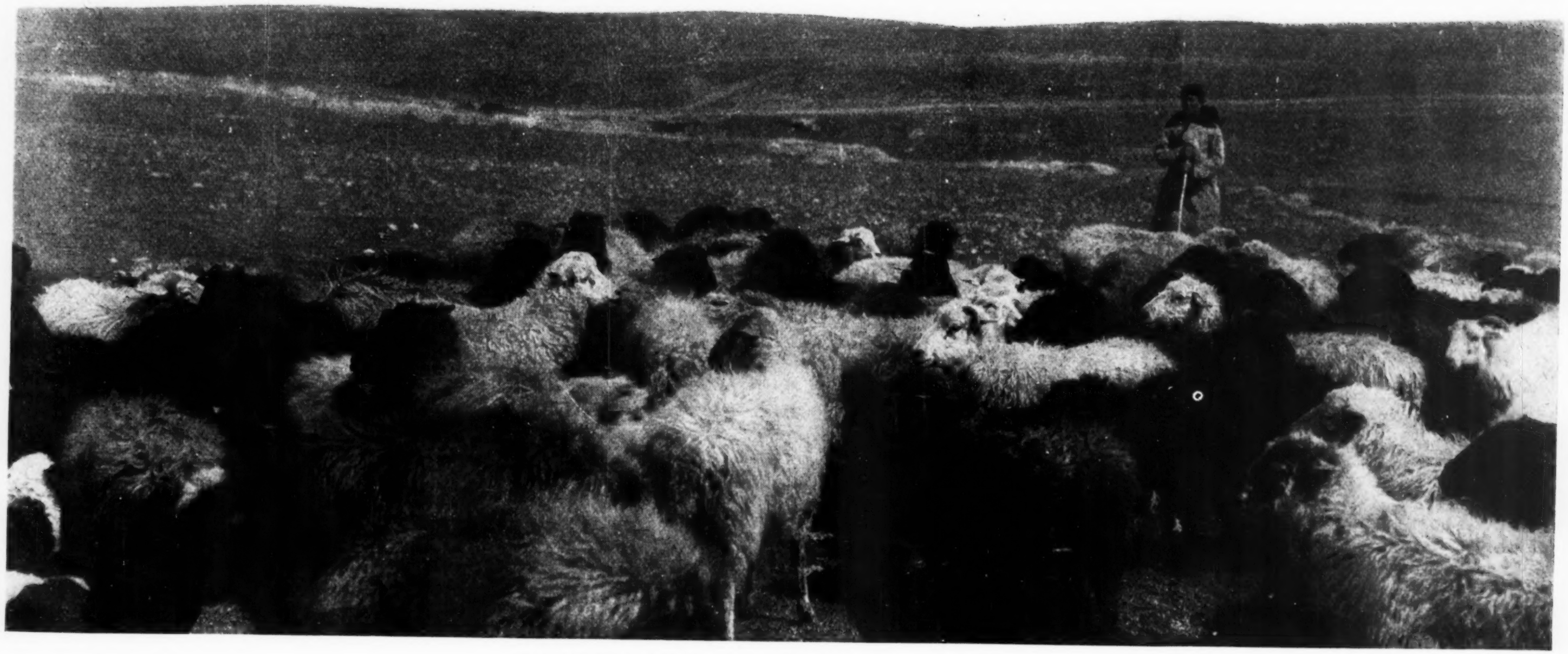
FIGURE 33. The lighter Malitch sheep generally produce a gray fur with open curls, the "Krimmer." The black animals often produce tight curls, due to the prepotency of the Danadar strain, obtained by crossing with Karakuls. Gray skins with tight curls are very rare, and few ever reach this country. Such skins are only produced by a large type of Karakul sheep called Doozbais, and the skins are called "Shiraz," a name sometimes also applied to black skins when the curls are small and very tight.

AFGHAN FINEWOOL SHEEP

FIGURE 34. By mixture with the finewool breeds the fur sheep industry of Central Asia is being rapidly and permanently ruined, as Karakul sheep contaminated with this strain will not produce skins with the prized tight, lustrous curls. The shepherds are Afghans, photographed by the author at Karshi, near the border of Afghanistan.

all of these characteristics except that some of the bucks are horned, come black at birth, turn gray at maturity, and the tail formation is such as to make them typical members of the broadtail breeds. It is true that Sinitzin's Doozbai contains much more fatrump admixture, evidenced by a broad tail of tremendous size. While many of them have enough black Danadar in them to come black, the majority of them come red, and in selecting them one should avoid those specimens in which the tail bears too close a resemblance to the fat pillows of the fatrumps.

As far as Sinitzin's Shiraz is concerned, that is largely a myth, but one finds, here and there, a typical Doozbai whose offspring come gray. The white is no doubt due to the little white Afghan finewool, the black that of the Danadar, and the red (I have seen Shiraz skins with all three of these colors) that of the fatrump. In all my three importations I brought only



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one Shiraz to this country and I am asking myself today why I wasted my money on him, as the gray skins produced by these peculiar accidents of atavism are almost invariably with open curls and therefore can easily be imitated by kid skins, which the furrier can buy for fifty cents apiece.

I have decided that the proper thing for the American breeder to do is to call all Central Asiatic sheep of the general type that I have brought to the United States Karakuls and to forget about everything else, as it is most confusing. It suffices to tell a novice that Karakuls are of various sizes and are not bred with a view of attaining uniformity of type, unless one is breeding them for mutton purposes; that the only thing that really counts is tightness of curl, and that all rams that fail to sire lambs with such curls in the first or second cross should be eliminated.

I have asked many specialists what caused the tight curl in the Karakul, or of the Negro in the genus Homo. Some thought it was due to keratin, which is more abundant in the coarser-wooled breeds than is the case in the finewools. That keratin gives us a certain stiffness, which causes the curl to remain closed, is possible. I know from numerous tests made by Professor Wallace of Edinburgh, Simonson, myself and others, that the Merino and Rambouilette will not give us even a semblance of tight curl formation in the first cross, in fact not even in the second cross, while certain coarsewools have often given us beautiful tight curls in the first cross. I would like to refer the reader to the bulletin issued by Professor Wallace which appeared in the Journal of the Board of Agriculture, August, 1915, which is printed under the authority of His Majesty's Stationery Office. Both rams mentioned were furnished by myself. But if keratin is the "Hauptgrund" then why does the wild Argali lamb, or some of the fatrump lambs of Central Asia, that have a coarser fleece than the best Karakuls, not come with tight curls? The same may be said of the Rocky Mountain sheep.

Errata

HUXLEY, JULIAN. *Glands and Development.* Vol. XIII, Pages 351 and 353. The statement under Figures 8 and 9 that thyroid extract *or iodine* produces metamorphosis in axolotls is an editorial error. In the fourth line under Figure 8 the words *iodine or* should be deleted. In the first line under Figure 9, for Iodine, read Thyroid.

DUNN, SCHNEIDER AND WEBB. *Inheritance of Spotting in Holstein Cattle.* Vol. XIV. Page 236. Thirteen lines from top of left-hand column, change 555.4 to read 455.4.

GARBER AND QUISENBERRY. *Origin of False Wild Oats.* Vol. XIV. Page 270. Fourth line under Figure 10, change *Avena nuda* to read *Avena fatua*. On page 268, five lines from bottom of left-hand column, read *second* generation.

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